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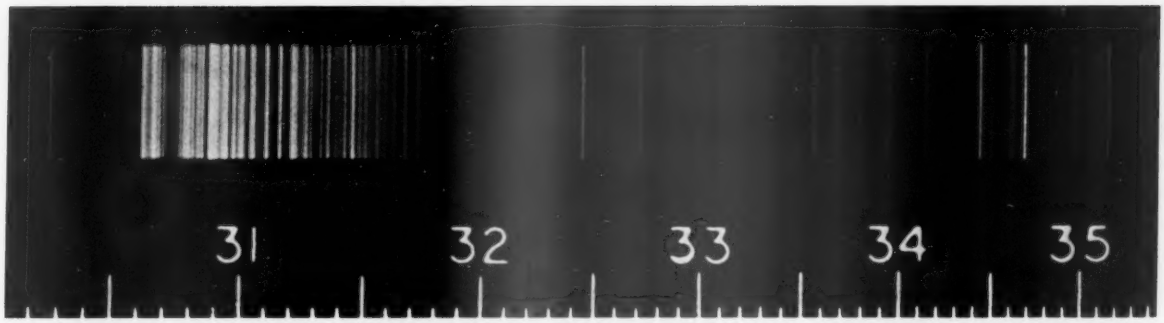

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THE TECHNOLOGY REVIEW

Edited at the Massachusetts Institute of Technology

VOLUME XXXIII · · · NUMBER 6

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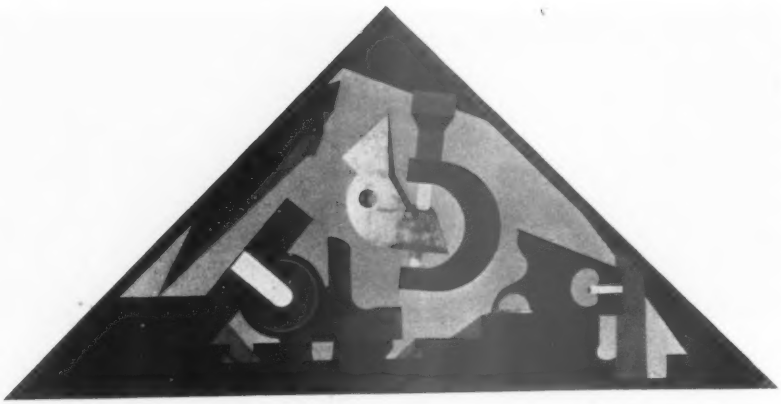
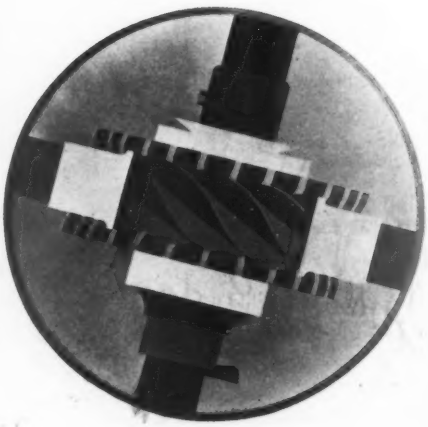
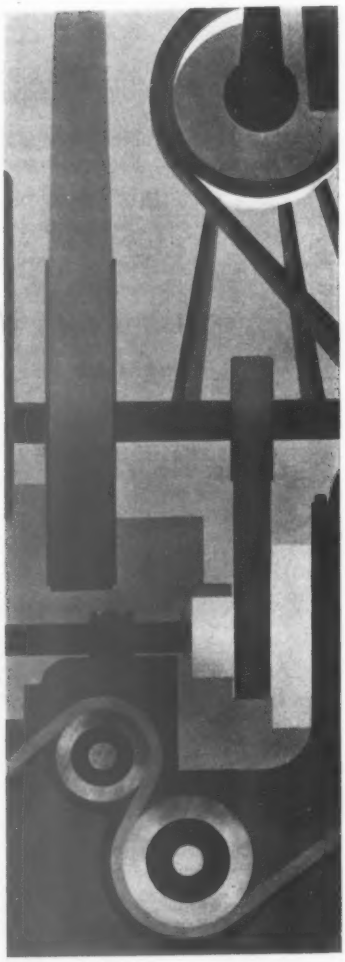


MURAL DECORATIONS

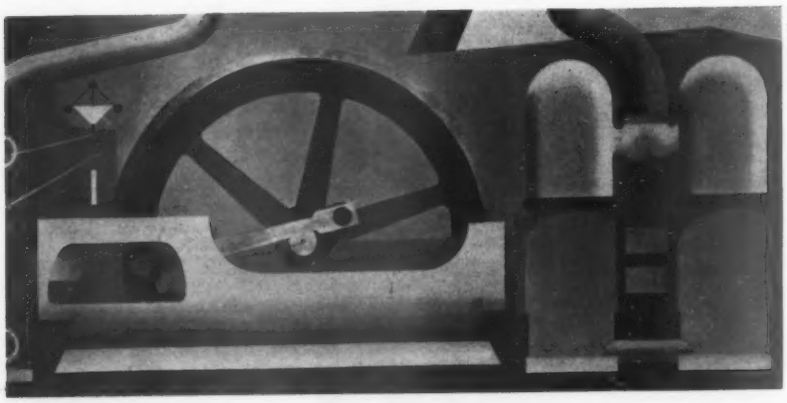
By Henry Billings





Based Upon

MODERN MACHINERY



THE TECHNOLOGY REVIEW

VOLUME 33 MARCH, 1931 NUMBER 6

MACHINE-MADE MINDS

The Psychological Effects of Modern Technology

BY JOHN BAKELESS

See Page 266

ONE would not willingly add another to the innumerable futile laments over the Machine Age — conventional complaints which by this time are merely wearisome. If there were not so much more that is tiresome, there would be something funny about our solemn modern devotees of the æsthetic Greek or Mediæval Past. Seated in Grand Rapids chairs at pressed steel desks in comfortable steel-and-concrete apartment houses (which are, of course, mechanically heated and lighted), in cities which owe their very existence to the machine, they bang out on thoroughly mechanical typewriters their ululations over the passing of the arts and handicrafts — sad victims of the machine, that fell and ferrous monster. (It may be objected that you can't bang out an ululation; but at least the metaphor is no more mixed up than the minds of the writers it describes.)

A little more knowledge of what life in the Middle Ages was like — of the brutality and filth and squalor that accompanied its picturesque charm; a somewhat more realistic comprehension of the seamy side of the attractive life of ancient Greece (in which a Plato could be sold into slavery and an Aristotle could cheerfully consign 90% of the population to the same fate in the interests of the cultured few) would speedily convince even the more aggressive critics of the machine and its products that a mechanical basis for society is not wholly without advantages. It might even persuade them that the engineer is not necessarily to be equated with the Goth or the Vandal.

There is no longer any doubt that the machine is here to stay. We shall have it to deal with as long as our peculiar type of civilization exists; and it is even probable that the continued existence of our civilization chiefly depends on whether we make a wise or a foolish use of the machine.

Peter A. Juley & Son

"STEEL-WORKER" FROM THOMAS H. BENTON'S MURALS "AMERICA TODAY" IN THE NEW SCHOOL FOR SOCIAL RESEARCH. TWO OTHER PANELS ARE SHOWN ON FOLLOWING PAGES

It is a curious fact that the writers who have dealt with the social, economic, and political effects of the machine have neglected the most important effect of all — its profound influence on the modern mind. Anything that shapes our thoughts shapes society also; and the effects of the machine on contemporary thought, must, therefore, be at least as significant as its effects on contemporary economics or industry, or the life of society in general.

Even our republican form of government is possible only because a few machines — mainly vehicles (railroads, airplanes, and motor cars) and means of communication (mails, telephone, telegraph, radio, wireless, and machine-made newspapers) — bring the minds of a continent sufficiently close so that we can live and work together. In fact, if we

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may trust Shakespeare, who certainly was not a product of the Machine Age, "there is nothing either good or bad, but thinking makes it so." If the machine really controls our thoughts, no wonder it controls all else.

But before we begin to worry over the fact that the modern mind is as completely machine-made as any other factor in Twentieth Century civilization, it may be just as well to analyze the effect of the machine upon the modern mind. Some of these effects, no doubt, are bad; but others — this, at least, is not beyond the bounds of possibility — may turn out to be good.

The machine exerts a dual influence over the mental life of modern man. In the first place, to a surprisingly large degree, it controls the subjects of our thoughts and the data on which our general ideas are based. In the second place, it has an almost equally powerful indirect influence upon the individual mind through the subtle influences arising from an environment and a mass psychology which the machine has itself created.

Mr. Stuart Chase, '10, has observed that "the number of those bound intimately to the rhythm of the machine is a small percentage of the total population." This is quite true; but through its indirect influence on our minds, the machine reaches out to dominate the life of every man and woman on the continent of North America.

Consider the mental equipment of the average modern man. Most of the raw material of his thought enters his mind by way of a machine of some kind — often through the agency of several machines. Newspapers, magazines, moving and talking pictures are the clearest examples.

The newspaper is not only one of the chief influences in swaying the ideas and prejudices of ourselves and our contemporaries; it is also a triumph of machinery and of mechanical organization. It differs immensely from the crude little newsbooks and corantos of the Seventeenth Century, but not because its editors and readers are greatly different from their ancestors who waited eagerly for the latest news from the army of King Charles or the wars against the Turk.

It is different for two quite different reasons: in the first place, the Twentieth Century journalist can collect, print, and distribute his news with a speed and completeness wholly due to a score or more of intricate machines. In the second place, mass production, another result of machine economy, gives the publisher an immense advertising revenue which commercially justifies enormous news-gathering expenditure.

All this creates an almost incalculable difference between the modern mind — the scholar's in his study, the technologist's in his laboratory, the engineer's in the field, as well as the giggling, gum-chewing shop-girl's on her way down town in the subway — and the mind of the Eighteenth or early Nineteenth Centuries. For the first time, thanks to machinery, such a thing as world-wide public opinion is becoming possible.

Thanks to the newspaper, the modern world knows more about itself every morning than the world before the industrial revolution ever knew. But this increase of self-awareness in the modern world is due to a number of other machine products besides the newspaper. The newspaper directly influences many contemporary books and magazines whose writers derive much of their inspiration, some of their methods, and all too many of their facts from the daily press.

It is notorious that every successful magazine editor is an inveterate newspaper reader. S. S. McClure used to have the leading American newspapers mailed to him, even when abroad; and the present dean of American magazine-makers reads English and American newspapers with the greatest assiduity. The machine's effect on the newspaper is thus carried over into more enduring form. Moreover, the book and the magazine are themselves largely machine-made from the moment the author delivers his manuscript to the editor or publisher. A cynic surveying most popular science and a good deal of popular fiction might easily be tempted to trace machine work even further back.

The rapid advance of pure science and technology, the most obvious single characteristic of our time, is also directly related to machine-production in publishing and the resultant ease, cheapness, and speed in making and distributing technical journals. A contemporary laboratory in Peking, Tokyo, or Calcutta is perfectly aware of the results achieved in other laboratories in Berlin, Paris, London, Oxford, and both the Cambridges. But Chinese scholars of the Chou dynasty did not even know that Athens existed or that Aristotle was lecturing there.

Under such conditions, progress in pure science and subsequent progress in its technical applications was necessarily slow, halting, unsure. One worker could not benefit by what another had done. The intellectual fertilization which results from a free exchange of ideas was impossible. There were many unrelated, feeble lines of advance, instead of one great, steady line strengthened by mutual coöperation.

"With the introduction of printing," says Mr. H. G. Wells, "the intellectual life of the world entered upon a new and far more vigorous phase. It ceased to be a little trickle from mind to mind; it became a broad flood, in which thousands and presently scores of thousands of minds participated."

The changes in our methods of making, reproducing, and distributing printing have had a somewhat similar effect. Art as a creation of hand, brain, and emotion in which the machine has no part is as old as the race. But the original work of the artist necessarily affected few people. The machine has made it possible to distribute fairly good reproductions far and wide at low cost. The machine has also made possible mechanical travel — of which more anon — bringing thousands of people to the galleries in which the great originals are housed, where only hundreds came before.

The crude, hand-drawn woodcuts of crimes, wonders, and disasters which adorned the early newsbooks had no more claim to art or accuracy than modern "composographs" in a contemporary tabloid. But in the Nineteenth Century, the camera came into general use and with it photo-engraving and the rotogravure process, making possible the modern illustrated press. Today we do not have to read the news. Even the illiterate can see it re-enacted in pictures, still or talking. They can even listen to a mild distortion of its sounds.

Our ideas of foreign lands can be changed overnight with pictures. A modern Othello, spinning yarns

> ". . . of the Cannibals that each other eat,
> The Anthropophagi, and men whose heads
> Do grow beneath their shoulders"

must bring photographs to prove his story and illustrate his lectures or his articles.

The effect of all this on art is curiously dual. Thanks to cheap reproduction, anyone who wants it can study any of the great masterpieces in an accurate photograph. One museum has even set itself the stupendous task of collecting reproductions of all the world's important paintings. The machine is thus a positive benefit. But it has had a very different effect on the progress of contemporary art. When the machine first made the modern magazine possible, the artists at first deserted their exhibitions to embellish the magazines, the result being a really great school of American illustration. This was destroyed when mass production — a result of machinery — led to enormous advertising campaigns and immense appropriations, which lured the artists out of the editorial and into the advertising pages. Many a promising young painter is today drawing pictures of motor cars and razor blades and cans of pork and beans not because he particularly enjoys it, but because it is infinitely more profitable than *l'art pour l'art*.

Peter A. Juley & Son

At the same time, the machine has found another use for art. The factory, which has long employed the artist — sometimes to strangely little purpose — as a designer of paper and textiles, is now reaching out for him as a designer of the most grotesquely improbable products. Not long ago the Westinghouse Company took an instructor from the Carnegie College of Fine Arts to add aesthetic quality to its products. It also sent its engineers to art classes. It had discovered that sound artistic and sound mechanical design tended to approach each other.

Thus, even while interfering with the purely creative work of the artist, the machine is beginning to surround us with agreeable objects of harmonious design — without the special charm of handicraft, no doubt, yet often with a new quality almost worthy to replace it. Sometimes, indeed, the artist turns to the machine for his ideas. And always, silently and subtly, the machine goes on transforming the mind of the modern world.

Quite as significant as the machine-made power of the press and of mechanically reproduced art upon our minds, are the various mechanical devices developed during the last two decades for pouring ideas into our eyes and ears — movies, talkies, radio, and television. Some of these mechanical devices probably have more effect upon the less literate levels of modern society than the printed word could ever hope to have.

ONE may, according to one's view of life, regard this state of affairs as dismal or desirable — or merely funny. The point here is only that the machines which produce this attitude are largely shaping the minds of the coming generation and, in less degree, the minds of the present generation. Even when we seek the allegedly broadening effects of travel, we moderns depend on the machine. In Europe, "tourisme" has become a major industry, enjoying the favor and protection of the state. It is an affair of advertising and organization, steamships, railroads, and motor cars. It is, in short, very much a part of the Machine Age. But it is an open question whether the modern, personally conducted tripper — who, with his ticket two yards long, is whirled breathlessly about the continent of Europe in six weeks — broadens his mind at all. One may even doubt whether anyone originally possessed of a mind would undertake such journeys. Certainly the bustling modern tripper does not broaden it a tenth as much as the English "milord" of the Eighteenth Century, who with his horse and chaise, in decorous leisure, made the "grand tour" of France and Italy; and whose desultory means of travel perforce compelled him to learn the country and its ways.

Only the favored few traveled in those days; but to judge by the urbanity of Eighteenth Century society, it did them some good. Today, the profiteers make their appointments at St. Moritz or the Lido instead of Toronto or Palm Beach, and all the deacons of America assemble nightly at the Folies Bergères. But if all this does anyone any good (except the hotel keepers and the steamship lines — operators of floating machines) no one has ever found it out.

Incidentally, since the machine has reduced most industrial countries to a flat uniformity, it is very nearly impossible for the traveler to find local color nearer than the Balkans, except where the inhabitants are ordered to be conscientiously picturesque for the benefit of the tourist industry. All this is the machine's doing. Machines transport the tourists. Machines produce the wealth to pay their bills.

The machine is also responsible for the transition from urban to industrial civilization. The time may be approaching when even the farm will be industrialized. If the Soviet agricultural experiment succeeds in Russia, the capitalistic countries may be compelled in self-defense to industrialize their own agriculture. We shall then substitute for our farms, "food factories," which will be very much more "efficient." That is, having already more farm products than we know what to do with, we shall add to their amount; and the privilege of premature demise from overeating will become less expensive and even more widely enjoyed than it is today. To offset these doubtful merits, something precious will go out of life, particularly out of the life of childhood, which will not be without its own ultimate effect.

Agriculture is a way of life which influences the whole of civilization. As Socrates once observed, it "gives strength to the body and hardihood to the soul" and is responsible for "the best citizens with the best understanding." Contemporary society could very well do with a little more of all these qualities; but whether mechanized agriculture, the ultimate triumph of the factory, will do much to enhance them, we may very reasonably doubt.

Worst of all, mankind will lose touch with its humble brothers of the lower creation. The machine is already driving animals out of human life. Horses have not completely vanished, but they have become luxuries, instead of familiar daily friends. Oxen, slow-plodding and picturesque, disappeared long since. Eggs, milk, and honey reach most of America's population nowadays with no more indication of their animal origin than a glass bottle, a tin can, or a cardboard case.

Now, odd as it may appear, this can hardly be without effect on the mind of modern man. Man and the animals have lived toegther almost from the beginning, perhaps from the day when a wolf cub was brought into camp to grow up as the first dog. Even before that, animals were gods and totems and blood-brothers of primitive man; and at the very least, they were his chief source of food and clothing.

The effects of man's severance from the lower creation and his new dependence on machines will probably be clearer in the next generation, the generation who now are children. Somehow, a boy and a dog have belonged together from time immemorial, and other animal pets and fellow workers have always been plentiful. Earlier generations in childhood dealt habitually with sentient creatures, not with unresponsive metal objects. In caring for them, they unconsciously developed a good many social virtues: a sense of responsibility; a sense of justice (if you punish a dog unjustly, your conscience will hurt you more than if you steal a dozen Ford cars); gentleness; sympathy. Of course, it didn't work perfectly; but there must certainly have been a general development, however unconscious, in every mind of capacity for certain virtues that human society badly needs. For genuine ethical influence, a really good dog is hard to beat.

It is painfully easy to sentimentalize over this sort of thing, and very difficult to make it seem concrete; because, in fact, it isn't very concrete. It is only real.

Walt Whitman, in "The Beasts," a poem that has been quoted very nearly to death, expressed it as well as anybody can:

"I think I could turn and live with the animals, they are so
placid and self-contained;
I stand and look at them long and long.
They do not sweat and whine about their condition;
They do not lie awake in the dark and weep for their sins;
They do not make me sick discussing their duty to God;
Not one is dissatisfied — not one is demented with the mania
of owning things;
Not one kneels to another nor to his kind that lived thousands
of years ago;
Not one is respectable or industrious over the whole earth."

You simply cannot write that kind of thing about the finest tractor ever designed.

NOT only does the machine directly determine the thinking of adults while subtly shaping the minds of the generation that will replace them; it also creates the environment in which we do our thinking. Here, again, it is easy to exaggerate an effect which is at best impalpable. But it is surely easy to see a relation between the mechanical nature of modern art and thought and the mechanical environment. The chief example before child and adult is the frenzied competition (*Continued on page 298*)

Fifty Pfennigs' Worth

The Great Industrial Museum in Munich

By Harry J. Carlson

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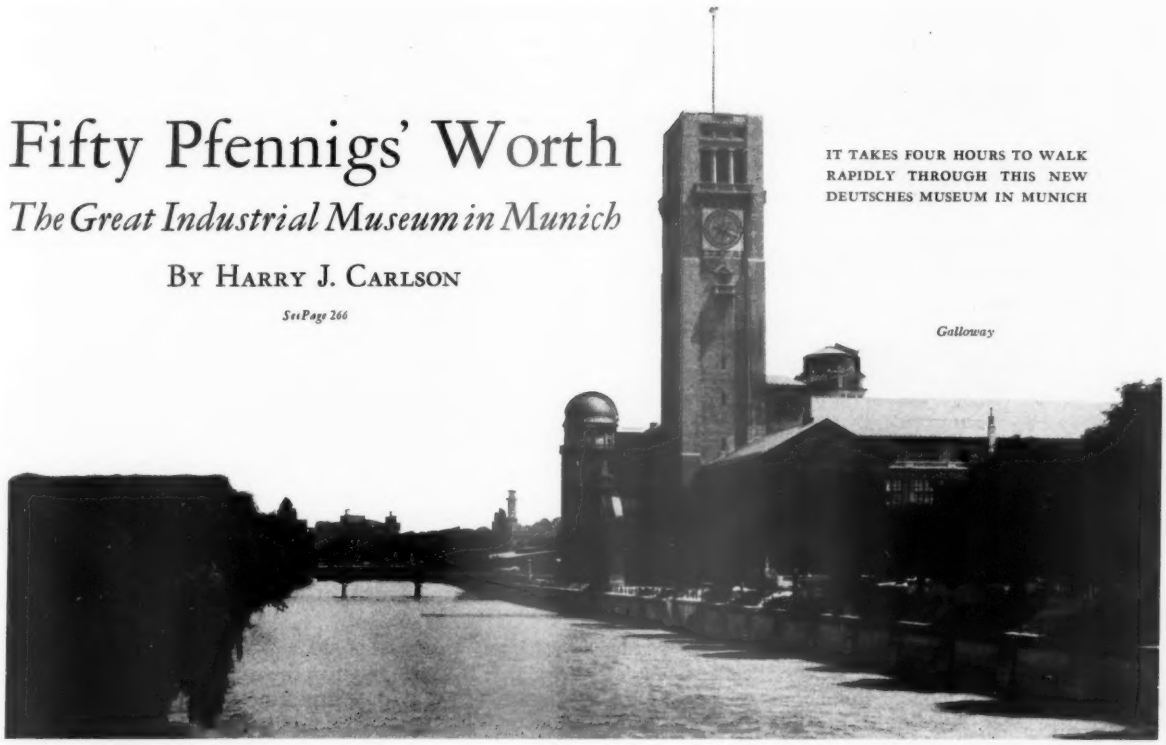


IT TAKES FOUR HOURS TO WALK RAPIDLY THROUGH THIS NEW DEUTSCHES MUSEUM IN MUNICH

Galloway

LAST summer I heard of a bridal couple who, on an all too short honeymoon, visited the Deutsches Museum in Munich and spent three happy days pushing the buttons that started machines. Anything that would bring these starry-eyed wanderers back to terra firma for that length of time must be worth seeing, and so, just as the "donkey went to Bremen," I started for Munich to see what the Deutsches Museum had to offer.

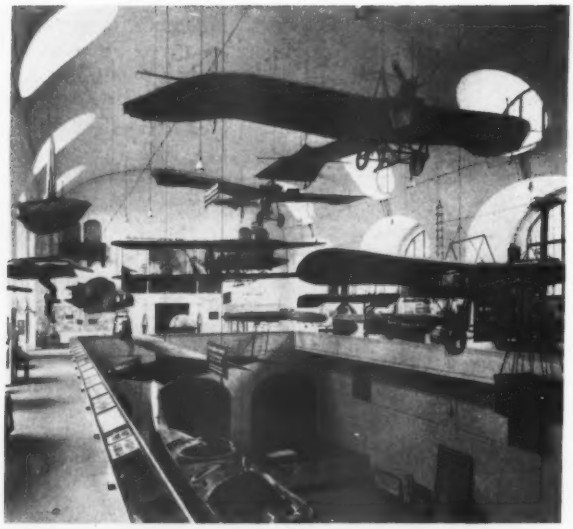
In the first place, the approach to Munich is most interesting. Surrounding towns like Neumarkt, Nördlingen, Ingolstadt, Regensburg, and even the more commercialized Oberammergau are all unspoiled relics of mediævalism, but Munich itself is an ultra-modern city of 700,000 inhabitants. The startling beauty of its new War Memorial, the great housing developments, the clean, well paved streets all attest to the city's enterprise and culture. The city occupies a great plain, looking off to the mountains of the South. The Museum, a huge building of three and four stories covering about nine acres of floor space, is located on the Museum Insel, one of the two long islands in the River Isar that separate Munich into two parts. The Museum is organized with the thoroughness that one expects of German scientists. It is divided into the following departments: administration, business office, new building, science, technology, industry, library, and workshop.

Bacon's motto, "I have taken all knowledge to be my province," might well be carved over the central portico. The high vaulted hall of fame in the second story gives a further idea of the breadth of the Museum's program, for here we find monuments of Goethe, and portraits or busts of such men as V. Humboldt, Frederick the Great, von Guericke, Leibnitz, Frauenhofer, Helmholtz, Gutenberg, Ohm, Krupp, Siemens, Copernicus, Kepler, Liebig, Bunsen, Lilienthal, von Zeppelin, and many others.

Space allows me to describe in detail only a few of these departments. Geology seems to be a natural beginning. We start with descriptive exhibits of the structure of the earth, its strata as represented by huge sections, and its raw materials of technology. From these exhibits it is but a step to the models showing the influence of water, ice, and wind on the earth's surface. The action of volcanoes and earthquakes is made clear as well as the origin of mountains and a large schematic section of the earth is presented showing the sedimentary layers and their corresponding fossils.

In adjacent rooms are depicted the search, production, and utilization of useful minerals. Portions of actual mines are presented with startling realism. Mining machinery, ore dressing by wet, mechanical, and electromagnetic systems can be operated by the visitor as can the jigging machines, shaking tables, and appliances for amalgamation and roasting processes. These mining exhibits date from the earliest times and methods and show their development into the most modern.

MUNICH'S WAR MEMORIAL TO THE UNKNOWN SOLDIER



THE HISTORY OF FLIGHT, FROM FLYING REPTILES TO THE LATEST AIRSHIPS AND AIRPLANES

The metallurgical department shows the production of lead, copper, zinc, mercury, iron, steel, and other metals.

The next group of exhibits shows the treatment of metals (from old to modern times) by casting, forging, and machine tools. Practically all of the machines can be set in motion by the observer. The foundry shows the processes of moulding, smelting, and casting. Hammers are exhibited operated by hand, water, steam, and compressed air. A model rolling mill shows the fabrication of sheet iron, rails, tubes, wheels, chains, and so on, together with machines for sawing, cutting, turning, milling, and grinding metals. There is a display of methods for testing and assaying metals and finally an exhibition room of fine castings, forgings, and coins.

Each department is arranged with the same completeness of detail as this first one devoted to mining, smelting, and metal working. Every department like it is arranged historically and in every place where it is practical machines on exhibition are so devised that the student observer can operate them by pressing a button. Others are started by an attendant.

Perhaps the department that presents the best examples of operating models is the power department which shows the development of prime movers. First there are the muscle power engines such as treadmills and horse-gears; then come windmills and steam engines, with a copy of Watts' first beam engine of 1788. There is a model of the first high pressure engine with an oscillating cylinder and a water-tube boiler of 1840; a replica of the first Corliss engine in Germany; ship engine models with multiple expansion by Schichau; and copies of locomobiles and steam turbine (Laval and Parsons). Then come steam boilers, hot air, gas, oil, and benzine motors, and special machines by Ericsson, Lenoir, Otto, and Diesel.

In the department of land transportation, samples of skates, skis, and stilts show the methods of foot-travel. The next group displays vehicles such as sedans, sledges, and carriages, including the gala coach and sled of King Ludwig II of Bavaria and some of the first models of automobiles. Cugnot's steam tractor, Serpollet's first steam road carriage, Benz's benzine motor, Daimler's petrol auto, the "Protos" car which won the first round-the-world prize in 1908, and Rumpler's first stream line car of 1921 are all represented in this group.

Then in another department is shown the development of the railway. There are full size models of the first locomotives (Puffing Billy of 1813) and other reproductions from the Rocket to the ultra-modern type which include expansion cylinders, superheaters, sleeping cars, air brakes, and so on. There are also exhibits from the first electrical locomotive by Werner v. Siemens, 1879, to the latest electrical train with full equipment.

This study of transportation leads naturally to the next department of road building where replicas of ancient Roman roads, German planked roads (dating back to 800 B.C.), mediæval mud roads, and model sections of old and new streets in German towns are exhibited. There are models of railroad construction (surface, under-ground, and elevated), mountain railways, rope railways; and models and appliances for tunnelling and bridge building. A study of hydraulic engineering displays replicas of mountain streams and river correction, ship locks and ship elevators, and models of the Rhine, Main, Danube, and Panama Canals.

The department of harbor operation shows miniature representations of the great harbors and basins of Bremen and Hamburg with beacons, buoys and signals above and below water; while in the department of ship building

MODEL POWER PLANT IN THE EXHIBIT OF THE EVOLUTION OF WATER-CONTROLLING MACHINERY

WATER AND STEAM POWER MACHINERY IN THE HALL OF PRIME MOVERS

there are models of outrigger canoes, kayaks, and dugouts. There are also models showing the evolution of rowing and sailing vessels and many duplicates of steam vessels including the *Charlotte Dundas* of 1801 and the *Leviathan*. There are also reproductions of battleships and submarines from the Fulton boat of 1798 to the modern U-boats equipped with torpedoes and mines. One alcove shows the development of the marine compass from the dry to the floating and electric gyroscopic compass of today. This department may well be supplemented by a visit to the Oceanographic Museum in Berlin.

One of the most popular departments is that of flight, of which illustrations are given adjacently.

The department of mathematics and physics has an interesting exhibition of instruments for measuring time (sundials, hour glasses, water and oil clocks); of implements showing average time, solar time, the rise and setting of the sun and moon, position of the planets, and so on. There are many beautiful watches and clocks, including the very cumbersome saddle watches of 1550 and the modern flat watch.

Another department shows the various measures of length, volume, and weight. Then follow a series of mathematical devices such as calculating machines, planimeters, compasses, and pantographs. There are also many drawings showing the evolution of descriptive geometry. Reproductions illustrating the development of the lever principle and the inclined plane, pendulum laws, gravitation, gyroscopes and their application are found in the division of mechanics.

A large alcove is devoted to the fundamental laws of hydrostatics and hydrodynamics, and to the mechanics of gases, with the original v. Guericke's air pump and his Magdeburg hemispheres on display. The study of heat and the laws of energy show the different methods of measuring temperature, the development of thermometers and calorimeters. Then there is apparatus for liquefying gases, accompanied by Linde's original machine of 1895, and also by a model of Rumford's famous gun barrel boring showing the transformation of work into heat.

In the section devoted to electricity and magnetism there are found such interesting machines as v. Guericke's sulphur ball, the electrical machine with battery of jars used by Ohm, and the original tubes of C. W. Röntgen. In this department are popular booths demonstrating the Röntgen treatment where an attendant sends rays through visitors' hands and purses. Mme. Curie is represented by a copy of the apparatus she used in her study of radio-activity.

ONE OF THE 60,000 DEVICES: A REPLICA OF ONE OF JAMES WATT'S STEAM ENGINES. PHOTOGRAPHS BY COURTESY OF CHICAGO MUSEUM OF SCIENCE AND INDUSTRY

In the telegraphy and telephony section there is an exhibit of telegraph instruments made by Sömmering, 1809, Steinheil, 1836, Morse and Siemens, and also telephone apparatus by Reis 1863 and Bell 1876. There are models of an exchange and of the more modern automatic exchange. Original instruments by Feddersen, Bezold, and Hertz showing the original oscillators, resonators, parabolic mirrors, with which Hertz proved the propagation of electrical waves, were displayed in this section. In the cases are innumerable condensers, self-induction coils, spark transmitters, coherers and crystal detectors, valve receivers, amplifiers and aerials, and daily demonstrations of broadcasting by telephones, and loud speakers are given. (*Continued on page* 302)

REVOLUTIONARY AVIATION

Introducing the Gyronauts

By Daniel C. Sayre

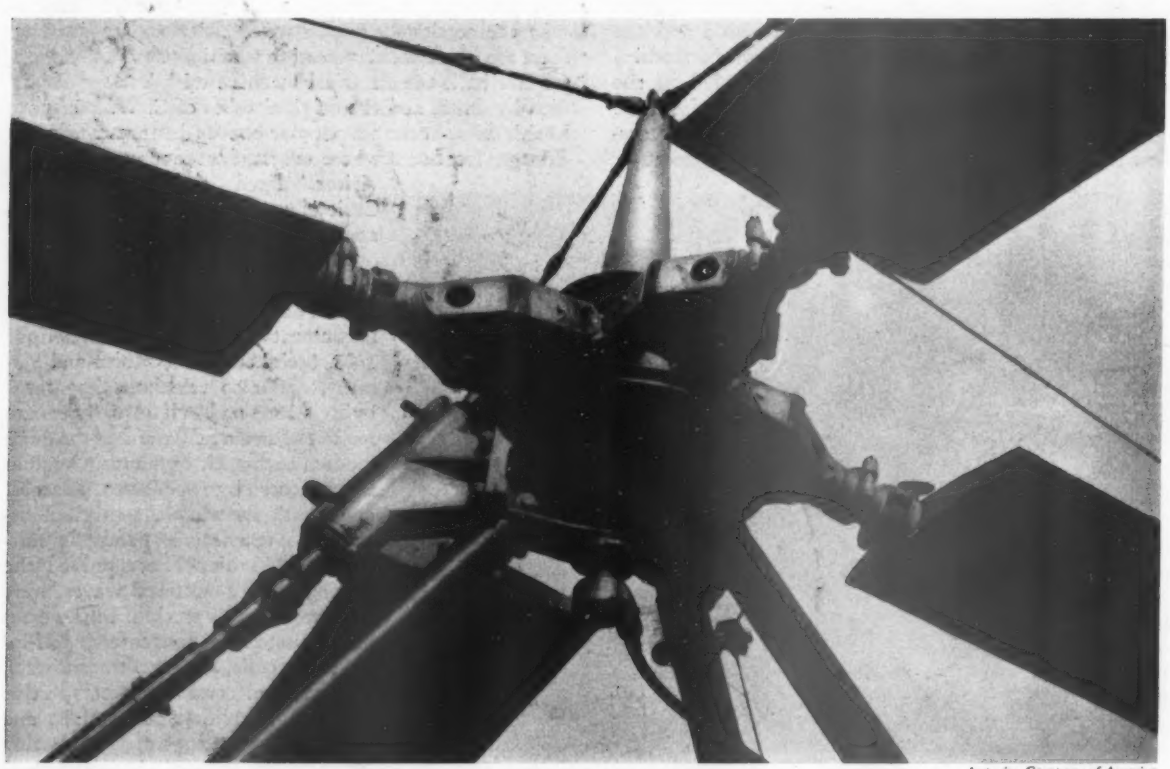
See Page 270

THE idea of flight sustained from rotating vanes is by no means new. The incomparable Leonardo is said to have built a successful model of a helicopter, and it is a simple thing to achieve in toy sizes. Other great inventors, among them Edison and the elder Berliner, have considered it the ultimate in aircraft. Nevertheless, a full-sized, pure helicopter is an extremely difficult problem. Reliance on lift from ordinary propellers directly driven from an engine, introduces gyroscopic forces, instabilities, and difficulties of control which are almost insurmountable. True, many such machines have been built and a number have achieved flight, if flight can be defined simply as ascent and a return to earth. The approach to controlled flight of any practical magnitude has been at best remote.

The autogiro is a horse of quite another color. In 1920 Juan de la Cierva, Spanish aeronautical engineer and mathematician, began the development work and in 1923 made his first successful flight. Since then continuous improvement has been achieved in a number of succeeding designs until at last, even the pilots of airplanes are growing interested.

The general appearance of the craft is familiar to all readers of rotogravure sections. An ordinary airplane fuselage with engine and propeller, a wide landing gear, and a small low wing characterize it. All the usual airplane control surfaces are present, and are rather large. Above the ship pivoted about a mast, are four vanes which look like nothing so much as a wind mill. These blades are *not* driven by the engine in flight. The giros, before the most recent type, taxied around the field like an ordinary plane until the blades started rotating due simply to the forward motion of the ship. The rotor turns about 100 r.p.m. in flight and from 60 to 80 r.p.m. is considered necessary for take off. At first it took plenty of taxying to achieve such a rotation. The early autogiros landed in a short distance but required an extremely large field for take off. The present models now start the blades through a hand-operated clutch from the engine. The run on the ground is, therefore, quite short.

The rotating blades exert a lifting force, which contributes to the total lift of the plane during forward flight and which makes possible the extremely slow landings. Descents can actually be made almost vertically from at



Autogiro Company of America

SHOWING THE CONSTRUCTION OF AN AUTOGIRO ROTOR HEAD

least 500 feet at a rate slower than the descent of a man in a parachute. The rotation during the descent is by no means entirely derived from momentum. As the resultant wind velocity past the blades departs from the horizontal, the resultant pressure on the blade section makes an angle with the vertical, pointing forward in the direction of rotation. The craft can, of course, also be brought in on an orthodox airplane glide at very low speeds.

The fastening of the blades at the mast is undoubtedly the kernel of the invention. They are articulated about two axes, are free to rise and fall like the ribs of an umbrella, and to change position in the horizontal plane like those of a fan. True, the blades are kept from collapse on the ground by individual cables running to the top of the mast and there are horizontal cables attached to spring mechanisms which preserve the plan pattern within a few degrees, but in flight the position of the vanes is determined by a resultant of gravitational, aerodynamic, and centrifugal forces. The results are several and highly desirable. The lift on the forward moving blades is larger than on the retreating ones because the resultant velocities are greater, therefore they rise. This, however, introduces a vertical component and decreases the lift through decreasing the angle between the resultant wind and the blade section. The opposite, of course, occurs on the retreating side. There is thus a balancing of forces as each vane passes around the mast. Secondly, the articulations completely eliminate gyroscopic forces. The autogiro can be banked and turned at least as easily as the ordinary airplane. Lastly the bending moment at the pin is made zero thereby reducing the design stresses.

Strangely enough, the resistance of this complex beast is not much greater than that of the corresponding airplane of similar power and pay load. The early autogiros were slow; so slow in fact that they fitted one airplane designer's famous question, "If you are just going up for the view, why not build a tower?" But the present models have a top speed in the neighborhood of 120 m.p.h. and carry three passengers. Their proponents are planning racers and trimotored transports. There are no theoretical reasons why they should not succeed.

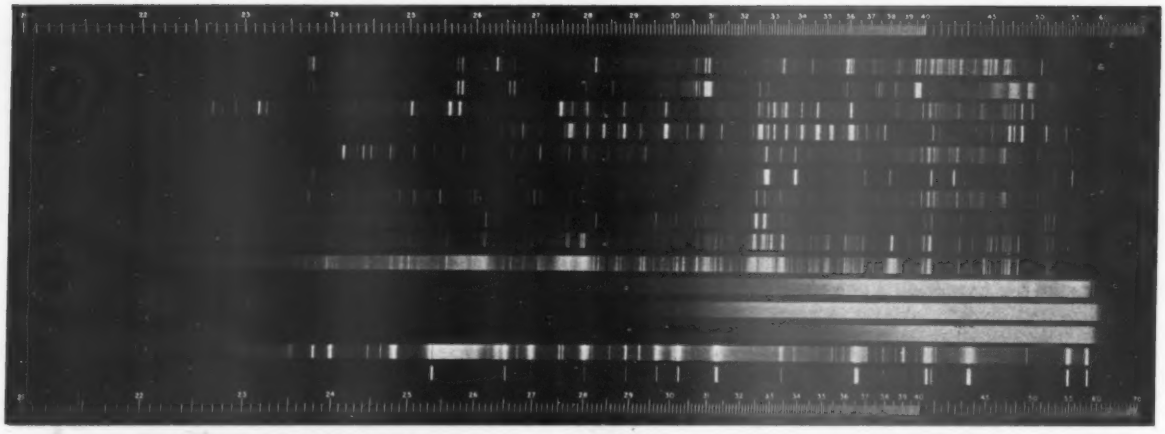
The things are quite easy to operate; about the same as an airplane. Those who are already pilots have no difficulty whatsoever. Instruction from scratch should be even a little shorter than for the plane. The controls in the cockpit are exactly those of the ordinary joy stick, with the addition of a clutch and brake for starting and stopping the blades on the ground. If there is any operating defect, it is that there can be no recourse to the engine within about 50 feet when approaching a landing in a steep descent, because the controls have lost a great deal of their effectiveness, even in the (*Concluded on page 307*)

Autogiro Company of America

AN AUTOGIRO IN FLIGHT OVER PHILADELPHIA

A DEFINITION AND A DISTINCTION

THE autogiro and the helicopter are similar in that they are both supported by rotating lifting surfaces. They differ in that the blades of the helicopter are directly driven from an engine while those of the autogiro are not connected to an engine during flight.



THE SPECTROSCOPIST LOOKS UPON THESE SPECTRA AS PATTERNS CHARACTERISTIC OF THE RADIATING ATOMS

LIGHT FROM DARK PLACES

And How a New Machine, the Synchronous Motion Spectrograph, Photographs 15,000 Spectra a Second

By Donald C. Stockbarger

See Page 268

With Sir Isaac Newton acting as *accoucheur*, the science of spectroscopy was born in 1666. The world well knows the story of how he decoyed a sunbeam, passed it through a prism, and obtained the colors of the rainbow. It was an experiment no less simple than it was epochal. In fact, it was one of the most seminal experiments in the history of science, for it has led man into a new world of physical discovery.

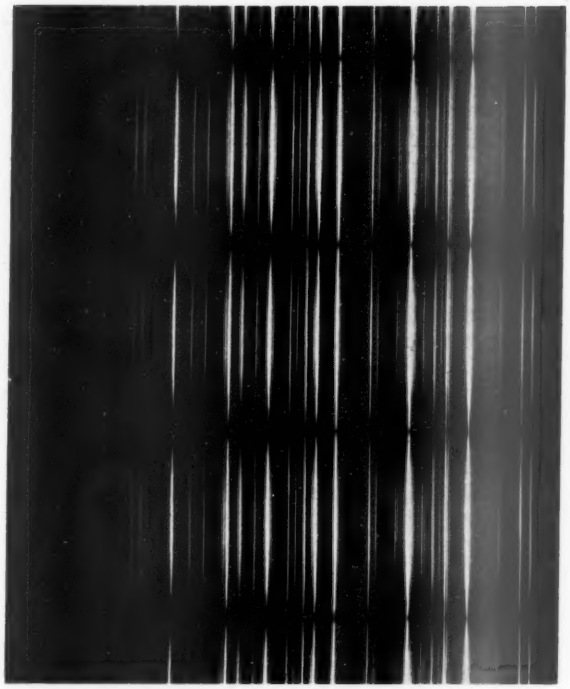
PHOTOGRAPH TAKEN BY SYNCHRONOUS MOTION SPECTROGRAPH

The prism that broke up white sunlight into rainbow colors for Sir Isaac was an elementary form of what we now term a spectroscope, a device able to break up light into its spectral parts. In its various forms (one of which, lately built at the Institute, is described below), the spectroscope has become one of the greatest of the tools of science, yielding secrets about chemical compounds otherwise undiscoverable, reaching out to the stars, breaking into the atom, showing the kinship of the infinitely large with the unbelievably small. Little wonder that the Institute is building a great spectroscopiclaboratory as a part of its new plant for physical and chemical research, spectroscopy being equally valuable to both the chemist and the physicist.

The spectroscope, in fact, has been partly responsible for effecting a new and fruitful alliance between the different branches of science which once were considered separately. It is only by their joint action that scientific knowledge and technique improves so rapidly, that we have better lights for our homes and factories, new methods of producing chemicals, more sensitive photoelectric cells for controlling an ever-increasing number of industrial processes, better vacuum tubes for our radios, therapeutic lamps for our homes and hospitals, more pleasing motion pictures, and a host of other things.

Although some spectroscopes are used as Newton used his, that is, for the visual examination of light, the majority now employ photographical or electrical means of detecting light. If, for example, the eyepiece of a visual spectroscope were to be replaced by a camera, we should then have a spectrograph capable of photographing not only the visible spectrum, but also parts of the invisible infrared and ultraviolet spectra as well. Spectrograms, the photographs taken with such instruments, are

EXAMPLE OF A BAND SPECTRUM



SPECTROGRAM OF TUNGSTEN MERCURY ARC IN QUARTZ TAKEN BY SYNCHRONOUS MOTION SPECTROGRAPH

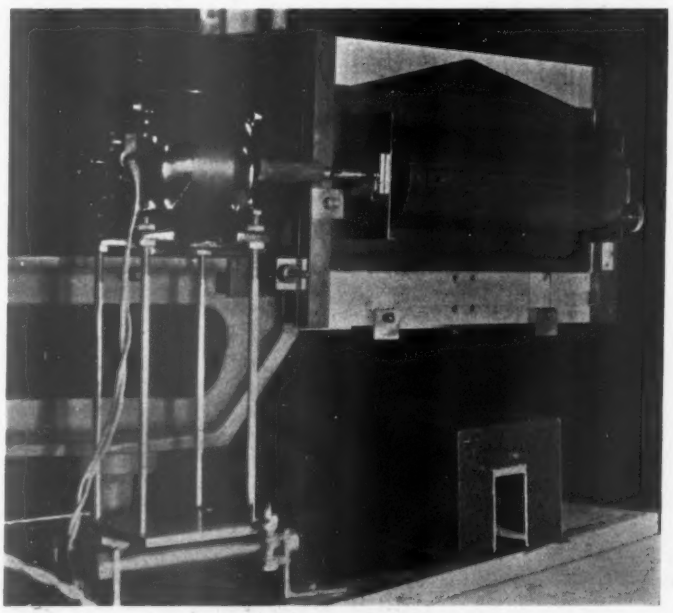
generally made whenever it is possible, for printed records are of much greater value than mere memories. They permit leisurely examination which is not always possible with a visual instrument, owing to the short duration of the spectrum.

Of the many methods which can be employed to produce the spectrum of a substance, perhaps the simplest is to place the material in a hole drilled in the end of one of the electrodes of a carbon arc. When the arc is lighted, the heat vaporizes the material; and the vapor, being formed in the arc itself, becomes electrically excited and therefore radiant. As a rule, the arc lines are so well fixed in position that the spectroscopist looks upon the spectrum as a pattern characteristic of the radiating atoms. This being so, if we were to send samples of gold to spectroscopic laboratories on opposite sides of the globe to have independent studies of the gold arc lines made, we might reasonably expect that two essentially identical reports would be forthcoming. It is to be expected that not only would the spectral patterns obtained by the laboratories look alike, that is, have the same number of prominent lines in any given region, but they would really be identical in that the individual lines would occupy the same positions in the two cases. So definite are the positions that certain readily measured lines are accepted as standards in wave length determinations.

There are, however, exceptions to these rules, and, as is so often the case, the exceptions prove to be of great importance. When the light from a star is examined spectroscopically the patterns of the different elements, superimposed on the photographic plate, of course, may be found to be shifted bodily toward either the red or the violet end of the spectrum. Stated otherwise, the wave lengths may all be too long or too short. If they are too long, the astronomer may conclude that the star is receding from us; if too short, that it is approaching us. Moreover, from the amount of the displacement he even calculates the star's speed along the line of sight.

Whether or not there is a displacement of the lines, the star's spectral pattern may be very remarkably altered in appearance from what we should expect on the basis of our everyday laboratory experience. Irregularities appear, the most notable of which is possibly the absence of ordinarily observed lines of elements known to be present in the star. From such apparent defects the astronomer is able to compute the temperature of the star, and it is interesting that these computations lead to estimates which agree fairly well with figures obtained otherwise. High temperature has such a profound influence that in extreme cases certain elements may be unable to emit any detectable radiation, and consequently, paradoxical as it may seem at first thought, complete absence of lines of an element in a star's spectrum does not necessarily indicate that that element is missing.

This is not the case in the laboratory, however, for here we can easily control conditions to insure obtaining a spectrum of practically any element which we wish to study. The chemist makes use of this fortunate situation in spectroscopic analysis with which he can detect quantities of elements so minute as to remind one of the old problem of locating a needle in a haystack. But he has not stopped at that. He has joined forces with the physicist to attack problems of very different natures. Together they are looking into the constitution of atoms and molecules, and thus not only (*Continued on page 306*)



SYNCHRONOUS MOTION SPECTROGRAPH

THE TREND OF AFFAIRS

Direct Versus Alternating

IN THE early days of electrical engineering, electric power was generated, distributed, and used in the form of direct current. The worm turned, however, and alternating current almost entirely displaced direct. This ascendancy of alternating current was the result of its quality of being easily changed from high to low voltage or *vice versa*, by means of transformers, direct current not then being amenable to such modification.

Will the worm turn again? At least part way, if a new device developed by Dr. Hull of Schenectady lives up to its present promise. This instrument, the thyratron, is capable of doing for direct current what the transformer does for alternating. Deriving from a study of the discharge of electricity through gases (one of the most fertile divisions of modern physics), the thyratron is a close relative of the well-known vacuum tube. Its output current may be started, stopped, and varied by minute quantities of power. In certain characteristics it is a million times more sensitive than the ordinary vacuum tube, and it can be designed to carry 100 amperes at 20,000 volts. It acts more swiftly than a relay, and its efficiency in high power operation is approximately 97%.

The promise that lies in the future perfection of the thyratron tube is that it would make possible improvement in the stabilization of long distance alternating current power systems; existing alternating current lines could be joined by direct current links, and long distance high voltage transmission of direct current would be possible with consequent increased carrying capacity and efficiency of transmission lines. The time may come when power produced by alternating generators will be converted to direct current for long distance transmission and delivered to the consumer as direct current or inverted by the thyratron tube to alternating current. Generating stations would become fewer and larger and the benefits of cheaper electricity would be extended to new fields of opportunity. It may bring to a close the *bellum internecinum* over the relative merits of alternating and direct current for the electrification of railroads.

Turning Poison Gas into Hair Tonic

THE ideal, if not the practice, of beating swords into plow shares is a common one. The metaphor, nevertheless, is an anachronism and on the basis of recent news it might be modernized by changing it to "turning poison gas into hair tonic." Such a change is highly to be desired, not only in the interest of rhetoric, but for the sake of those whose pates are bare, or in loftier language, in just recognition of what war, peace, and science are doing to curb parietal depilation.

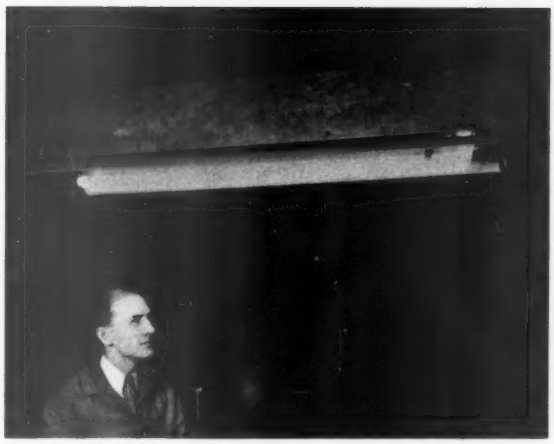
The simple truth is that "mustard gas" or dichlorethylsulphide, as it is more felicitously termed, may be an efficient promoter of hair growth. The *Journal* of the

Maurice Goldberg

A PROJECTED TEMPLE OF MUSIC DESIGNED BY NORMAN BEL GEDDES FOR THE CHICAGO WORLD'S FAIR IN 1933. IT HAS A SEATING CAPACITY OF 10,000

American Medical Association reports that "dichlorethylsulphide in high dilution was the most efficient hair growth promoter of a considerable number of agents tried. Quantitative estimations of hair growth on shaved cats, treated locally with concentrations of 0.01% of the compound in 50% alcohol containing 2% of glycerin, showed a much greater production of hair than with tincture of cantharides, 1% mustard oil, and ointment containing 33% of cholesterol, a hydrolysate of hair, tincture of cinchona, and certain proprietaries containing the so-called hair ferment and other constituents. The hair grew not only more abundantly but also longer than in the untreated control areas. Impure yellow petrolatum, but not the pure white product, was next in efficiency to dichlorethylsulphide, this being attributed to impurities acting as irritants."

The *Journal*, however, points out that the results of hair tonics on cats should not arouse premature hopes in bald humans, since all shaved and bald skins do not respond equally well.



NEW GAS TUBE FOR GENERAL ILLUMINATION DEVELOPED BY CLAUDE NEON LIGHTS, INC., TO OPERATE ON LOW VOLTAGES. IF LONGEVITY HAS BEEN OBTAINED IN THIS LAMP, IT IS A NOTABLE DEVELOPMENT

A Universal Law of Nature

THE law of gravitation, that matter attracts matter, is a law of wide application for it applies throughout the material world to all kinds of gross matter in any kind of a situation. There are laws of still greater generality which apply to material and immaterial things alike, not only in physics and chemistry and biology but also in economics, ethics, psychology, and sociology as well. Perhaps no law of nature is more general than the generalized Principle of Le Chatelier. Recent advances in the sciences support this statement.

If we attempt to produce a change in a system which is in real or pseudo-equilibrium, the system spontaneously alters in some manner different from the manner in which we are attempting to change it and in a manner to reduce the change we are attempting to produce. Putting the same thing in another way: if we have a *status quo* — a man, or a group of people, or a snowball, or a system of banking, or a mixture of chemicals in a flask — and attempt to alter it, the *status quo* spontaneously alters in a manner to counteract our attempt. The law appears to be universal. It may be called the Law of the Persistence of the *Status Quo*.

If we compress a gas, it warms up and becomes more difficult to compress than the cooler one would be. If we expand a gas, it cools down and doesn't expand as much as it would if it were warmer.

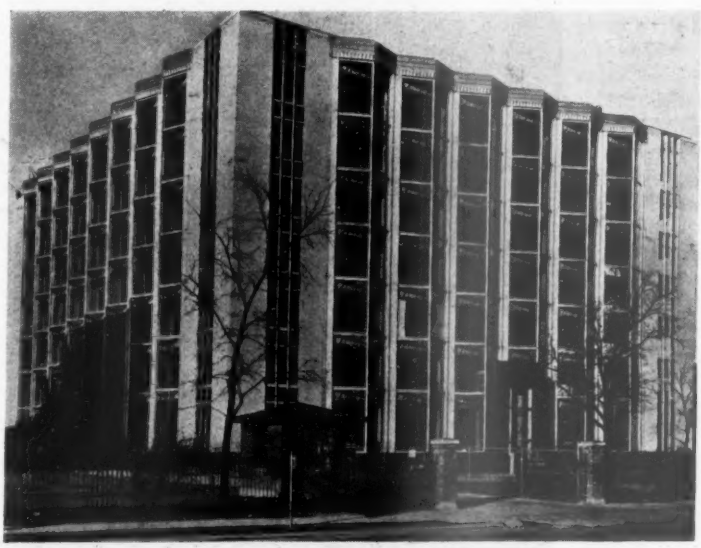
If we have a mixture of chemicals in equilibrium and attempt to increase the concentration of one of the components by adding a quantity of it, a reaction occurs, the equilibrium shifts, and the increase in the concentration of the substance which we have added is not as great as the amount which was actually put in. This special case of the general principle is called the Law of Mass Action.

A high pressure synthesis, such as that employed in making ammonia from hydrogen and nitrogen, is an interesting example. If we attempt to increase the concentration of the hydrogen and nitrogen by compressing the mixture, the gases combine to form ammonia and the concentration does not increase as much as it otherwise would.

If we attempt to compress ice, it melts. The water occupies less volume than the ice, and it resists our efforts to compress it further. If we release the pressure, the water freezes again. This is the *modus operandi* of making snowballs.

If we overstock the market with some commodity, the price drops and the commodity disappears from the market faster than it did before.

If people living on the products of their own agriculture have a high birth rate and tend to increase in number, they tend to specialize on the most convenient and



NEW A. O. SMITH CORPORATION RESEARCH AND ENGINEERING BUILDING. IT WILL HOUSE 1,000 ENGINEERS AND SCIENTISTS AND REPRESENTS MANY INNOVATIONS IN STRUCTURAL DESIGN

Courtesy Inertol Company

LAYING PRE-CAST ROADWAY SLABS ON THE WABASH AVENUE BRIDGE, CHICAGO

economical crop, and develop dietary diseases which again reduce the rate of increase of the population. This has happened in the Orient.

As to money: "easy come, easy go" is a well-known truth of human experience, and the bank account does not increase as fast as the income.

In ethics, ignorance is not virtue, innocence is not goodness. One must know evil to be wholly good, but all is not gain, for some of the evil sticks. Our efforts to be really good defeat their own purpose to some extent.

So it goes. There is hardly a situation to be found, if we describe it from the proper point of view, which does not illustrate the law of the persistence of the *status quo*. It is the law of the constancy of the form of nature, or the law of the flexibility of nature, according to our way of looking at it. If we make persistent efforts to alter a situation, nature has a way of wriggling out from under our efforts and the way she chooses is a way we have to discover by experiment.

Food Facts

BATTLES of the food technologist to make foods available throughout the year in their original state of freshness and flavor continue with marked success. We list below with acknowledgments to our contemporary, *Food Industry*, some of the recent accomplishments in preparing and preserving perishable foods.

1. The marketing of tomato juice in glass and tin containers.

2. Whole grain corn, in brine or packed dry in vacuum cans, is now in a stage of advanced commercial development. This corn is said to possess its natural flavor.

3. Irish potatoes are now being canned in Florida.

4. Other pending developments in canning include quicker methods of sterilizing, and the use of transparent or window type containers. Another trend is the increasing use of interior enamelled cans for both fruits and vegetables.

5. Fruit juices, frozen to preserve their natural flavor, indicate a trend away from the old-style imitation-flavor carbonated drinks. Another step from which much is expected is the Heyman process from which sterile carbonated beverages are produced by pasteurizing before carbonating. By this process concentrated syrups are heated to pasteurizing temperatures, then placed in sterile bottles and filled with sterile boiling hot water under pressure. Still under pressure, the neck space of the bottles is filled with carbon dioxide gas, and the bottle crowned.

6. A new process for preparing chocolate milk includes the addition of a hot liquid concentrate made from a mixture of powdered milk and cocoa powder with sugar placed in sterile bottles and filled with water at 260° F. for final sterilization.

7. Fruit juices are being prepared by evaporation in a vacuum at a very low temperature. The result is a thick liquid which is then mixed with granulated sugar and dried. Electrical pasteurization of beverages is being tested.

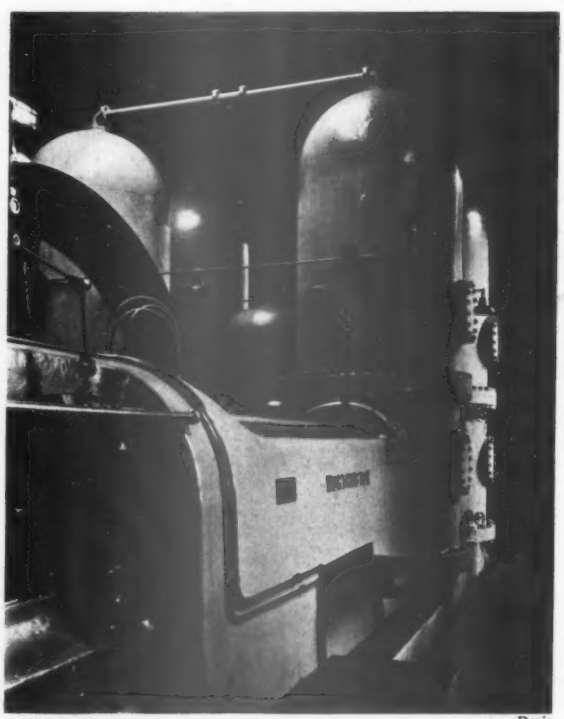
8. New machinery has been designed for the dairy industry, and canned cream of 18% and 36% butter fat content appeared on the market for the first time.

9. One large dairy firm is carrying on intensive dairy research to find a satisfactory method of producing milk containing desirable quantities of vitamin D as drawn from the cow.

10. In the preservation of foods, the most impressive advance in the past year was the development of methods of quick freezing, which holds high promise for the future. In preventing spoilage of fruits, ethylene is being widely used for ripening citrus fruits and for blanching of celery and other products.

11. Fungus or mould control, once considered impractical, is now recognized as necessary.

12. In the manufacture of sugar, experiments are being made on the storage of beet sugar in silos rather than in bags. On the Pacific Coast tests are being made



Davis

NEW PUMPING ENGINE AT THE FRESH POND PUMPING STATION, CAMBRIDGE, MASS.

involving two important steps in sugar refining. These are the use of a vacuum filter instead of a centrifugal massecuite, and the development of a process of boiling sugar to grain automatically.

Battling the Bookworm

INSECTS are no respecters of rare books. Urged by hunger, they do not hesitate to feed on the most precious material. Constant vigilance is necessary to prevent their ravages. Imagine the consternation of the Huntington Library (California) authorities when some time ago they discovered that some of their great treasures were being attacked by these pests.

As a preliminary to a campaign against predatory insects, it is desirable to identify the species and to study its life history. It must be remembered that what the layman calls "bookworms" are usually not worms at all, but beetles (sometimes they are humans!); and that the damage to the books is done when the insect is in the larval stage. When the insects were first discovered in the Huntington Library, the services of a trained entomologist were enlisted to identify the insect enemy and he soon found its name to be *sitrodopa panicea*. This beetle lays its eggs in the interior of a book; when the eggs hatch into the larva, these begin to feed on the paper of the book, finally emerging as beetles.

Knowing this life history, the next thing was to devise a method of killing the egg and larva. And at this stage the services of a chemist, a professor in the California Institute of Technology, were enlisted. The ordinary, well-known method of killing insects with surety is by the use of hydrocyanic acid gas. But in this particular instance, this virulent poison was out of the question, for if it were used to fumigate the books, the gas would seriously injure the gold lettering on the fine bindings. After months of experimentation, the chemist devised a gaseous mixture made from liquid carbon dioxide and liquid ethylene oxide, which had the desired properties as an insecticide, but was neither inflammable nor in any way injurious to the books.

M. I. T. Photo

IMPACT! A PILE DRIVER IN ACTION

Claude E. Patch

BRIDGE ON THE DANUBE AT CERNAVODA, DESIGNED BY BELGIAN ENGINEERS

A new difficulty, however, confronted the investigators. It was found that the eggs of the beetle were enveloped in a very thin gas-proof membrane, which protected them against the poisonous gas. It was useless to attempt to kill the larva if the eggs were left to develop other larvae. This seemed at first to be an insoluble difficulty. However, a third research worker, a physicist probably, found that if the eggs were submitted to the action of a high vacuum, the air within the egg, by its expansion, ruptured the protecting membrane and thus exposed the egg to the action of the mixed gases.

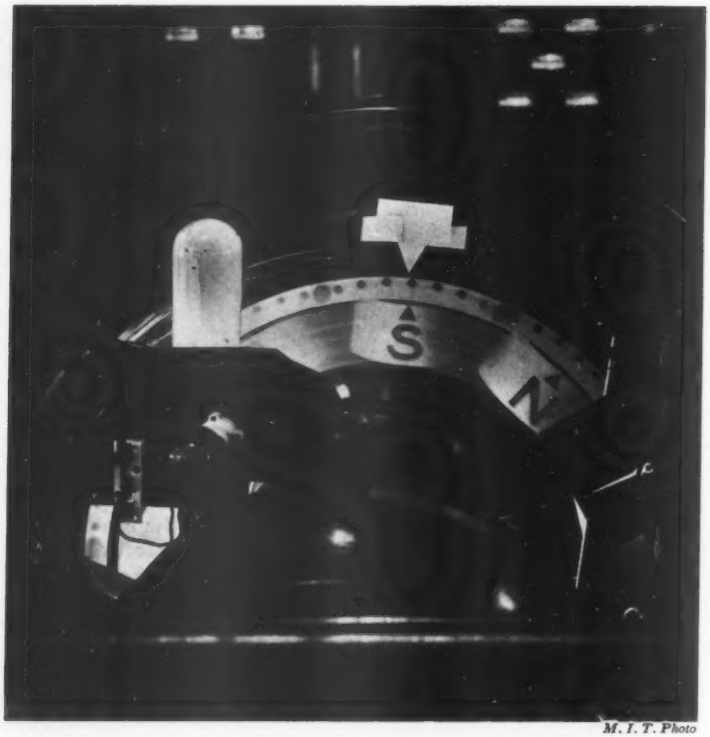
It only remained for a fourth research man, this time a mechanical engineer, to devise the appropriate apparatus to apply both vacuum and compressed gas to the affected books and manuscripts. This took the shape of a large tank or fumigator of half-inch metal, fitted with openings for introducing the material to be treated, and also having connection with a mixing chamber in which the lethal gaseous mixture could be prepared.

The books and manuscripts, placed on library trucks, are wheeled into the fumigator, the air exhausted to crack the egg-membrane, and the gas for treatment introduced from the mixing chamber. Thus neither insect or egg can escape the double action.

Thus, through the combined efforts of four scientific men, the danger of the destruction of the most valuable private library has been averted. Future generations must thank these men, and the library authorities who had sufficient belief in the value of research to employ them to solve this very perplexing problem.

The Age of Alloys

HISTORIANS, prompted by a love for making facile classifications, have neatly divided history, giving their divisions such names as the Stone Age, Bronze Age, and the Steel Age. The latter, applying to modern



M. I. T. Photo

PHOTOGRAPH OF A MOTOR ROTOR TURNING AT A RATE CORRESPONDING TO A LINEAR SPEED OF 95 MILES PER HOUR. SUCH PHOTOGRAPHS ARE MADE POSSIBLE BY A NEW STROBOSCOPE ("WHIRLING WATCHER") DESIGNED BY HAROLD E. EDGERTON OF THE INSTITUTE'S DEPARTMENT OF ELECTRICAL ENGINEERING. IT MAKES POSSIBLE HIGHLY ACCURATE STUDIES OF THE ANGULAR DISPLACEMENT OF MOTORS AND GENERATORS DURING SWITCHING AND SHORT-CIRCUIT DISTURBANCES

times, is loose, and if we must have a category wherein to place ourselves, we might better name it the Metal Age, or perhaps yet more accurately, the Alloy Age.

So much has been written on the use of steel and the development of the modern nickel-steel alloys, that there is danger that we may overlook the application of other metals for a wide variety of uses. The place that copper alloys occupy in modern civilization is, for example, quite often not fully appreciated.

Brass and bronze are familiar alloys of copper, but modern metallurgy has produced a number of new ones which have remarkable properties. Brass, the most ancient alloy of copper, is a combination of that metal with zinc. The alloys of copper with the same amount of zinc are known as commercial bronze and red brass. This alloy is commonly used for window screening, the manufacture of cartridges, and for a great variety of ornamental articles. Red brass makes the highest grade of brass pipes, because of its great resistance to corrosion in water. In fact, red brass has a greater resistance to sea-water corrosion than copper itself.

The familiar yellow brass encountered in everyday experience is an alloy which varies in content from 75% copper, 25% zinc, to 63% copper and 37% zinc. Beyond that lie the brass alloys containing about 40% zinc, which can be hot rolled and forged, and are now used for a great variety of engineering purposes. Three of America's cup defenders — the *Enterprise*, *Yankee*, and *Weetamoe* — were built with hulls of tobin bronze, an alloy of this type. The hull plating of these yachts each required approximately 55,000 pounds of tobin bronze, or 33,000 pounds of copper and 22,000 pounds of zinc.

Among the copper alloys now being produced are:

I. *Nickel Alloys*. Alloys of copper and nickel, because of new developments, are assuming great importance. The old name for such alloys was german silver. This alloy has been widely used in silver-plated tableware, and is now finding many new uses.

II. *Cupro Nickel*. In cupro nickel the alloy is produced by adding a small percentage of zinc to copper, which improves its resistance to corrosion, as well as the working properties of the alloy. The zinc acts as a deoxidizing and desulphurizing agent, increasing the resistance to corrosion and the malleability and density of the alloy. These copper-nickel alloys are being used extensively for architectural work, both interior and exterior. During the World War, the British Navy had a great deal of trouble with leaking condenser tubes. As a result, studies were made, and from them has been developed a so-called Super-Nickel condenser tube metal with a composition of 70% copper and 30% nickel. Alloys of this type are being used in many public buildings for plumbing fixtures, because the metal is white in color, easy to maintain, and is more durable than brass.

III. *Silicon Bronze*. Advances in electrometallurgy, which brought about production of silicon of high purity at a reasonable price, led to the development of silicon-copper alloys. During the World War, in the face of a shortage of tin, C. B. Jacobs, an engineer of the E. I. du Pont de Nemours and Company, started to make silicon-copper alloy parts to take the place of ordinary bronze for resisting chemical action. This alloy was found to be superior to tin bronze, and a range of compositions was patented. This metal has some of the characteristics of steel in strength and hardness, and has a high resistance to corrosion.

IV. *Tempaloy*. A new alloy known as tempaloy is copper hardened with nickel and silicon. The addition of aluminum strengthens it and considerably accentuates its hardening properties. Such material, on account of its physical properties and corrosion resistance, is excellent for shafts in speed boats and other high-powered vessels.

V. *Aluminum Bronze*. Although aluminum bronze is not a new alloy, it is finding increasing recognition, particularly in the development of aircraft. Copper-aluminum alloys are readily extruded, hot rolled, and forged. Such a bronze was used for the valve seats in the engine of the *Spirit of St. Louis*.

VI. *Beryllium*. As pointed out in the February Review, much is being heard now about beryllium, the metal of the beryl and the emerald. This metal is lighter than

aluminum and much harder. It readily alloys with copper, and is about five times as effective as tin.

VII. *Silver.* Attention is now being given to the study of alloys of copper and a small percent of silver. Research so far indicates that there are possibilities for alloys of this type.

Without discounting the great value of steel, it is a fact, nevertheless, that without copper steel could not be employed for many of its present uses. This is particularly true in machinery which would be useless without bearings and bushings of copper or copper alloys. The amount of copper used for this purpose last year was 48,000 tons, or 4.22% of the copper used in this country.

The uses to which copper is put are more varied than for any other metal, except iron or steel. Well-known forms are sheets, strips, rods, wire, tube, pipes, and many other shapes.

The metal is easily alloyed with others, although there are some metals with which it will not mix. The alloy of copper generally increases its strength, but decreases its conductivity for electricity and heat.

The Engineer as Artist

ALTHOUGH the design and construction of almost every great engineering structure takes into consideration beauty of line and form, engineers are seldom given credit for an appreciation of art and its application in their profession.

Engineering knowledge alone never gave to a great bridge the beauty of sweeping arch, and a sense of balance in steel and stone, nor has the modern slender skyscraper been developed without a keen appreciation of beauty and good taste. In the application of art in his profession the designer and the builder face a task far more difficult than the artist who, working freely with color and line, may give full rein to his imagination. The engineer, however, combines beauty with utility. His bridges and his buildings, his great dams and power plants, his ships and locomotives must be designed and constructed to definite specifications of safety and usefulness. It is in his admirable balance of engineering knowledge and beauty that he manifests in his works the leaven of a fine imagination.

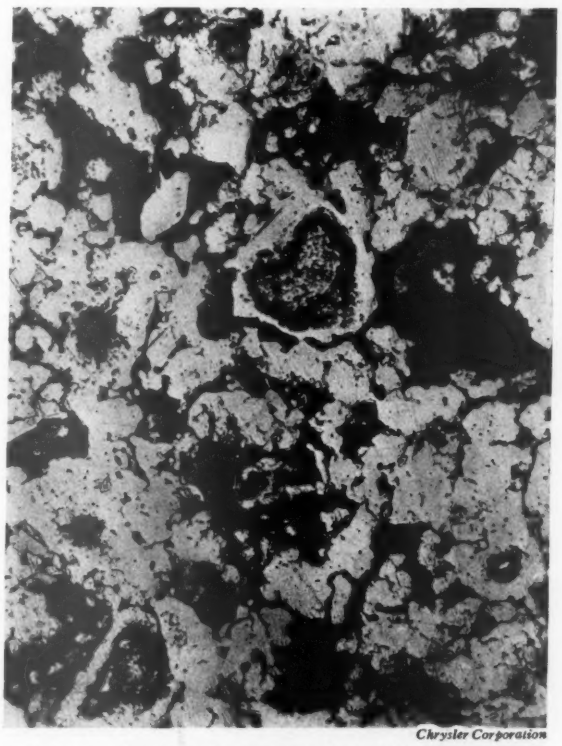
At the annual meeting of the American Society of Mechanical Engineers in New York early in December there was an exhibition of art in which the skill of hundreds of engineers in various branches of the profession was shown most impressively. Of the hundreds of paintings, etchings, drawings, and fine photographs submitted, it was possible to hang less than three hundred exhibits. And these, in choice of subject, conception, and skill in execution, were evidence of the artistic ability of hundreds of engineers who from time to time turn from the drafting board and building to work with pen, pencil, and brush in a hobby which must enrich their knowledge as engineers.

The High Price of Radium

DEEP in the jungle of the Katanga district of the Belgian Congo in Africa is a small mine in which lies the world's richest store of radium. The Chinkolobwe mine, controlled by the Union of Minerie du Haut Katanga, is a mysterious place, carefully guarded from intruders. It lies in the southeast corner of the Belgian Congo, just north of the Rhodesian border. To the east of it lies Lake Bangweulu. Beyond that, alone in the jungle not far from Lake Nyanza, stands the memorial to David Livingstone.

To this isolated spot Dr. Hayden Guest, a physician and a member of the British Parliament, recently went in search of information that might throw some light on the production and cost of radium. Dr. Guest represented the *Daily Herald* of London. It was his purpose to determine whether the price of radium, which in the United States is $70,000 a gram, is justified. He went down to the crude little mine in Katanga because this "hole in the ground" controls the world's supply of this very rare mineral.

Soon after Pierre and Madame Curie discovered radium in 1898, the mineral could be bought for as low as $2,500 a gram. In 1910 small quantities of radium were found in Bohemia, and four years later deposits of an ore in which the mineral is found were discovered in the United States. The yield from this source was sold in the United States for $120,000 per gram, and from 200 to 400 tons of rock had to be crushed to yield that small amount. The American deposits were found in Colorado and Utah. Other sources are Australia, Portugal, and Czechoslovakia. The rich store of ore in the Congo was not discovered until 1915. The ore from which the radium is produced in this district is oxide of uranium, and



Chrysler Corporation

SECTION OF A NEW SELF-OILING BEARING METAL, OILITE, MAGNIFIED 500 TIMES. ITS POROUS NATURE IS APPARENT, DARK AREAS REPRESENTING OIL

it is said that the yield is a gram for every ten tons of ore, by far the richest so far discovered.

The mysterious Chinkolobwe mine is surrounded by barbed wire entanglements, and visitors are barred from it. Nevertheless, Dr. Guest with his wife drove directly to the mine. He found there an open quarry from which galleries penetrated into the earth. The ore was hauled up from the bottom of the quarry on a cable tramway. The mine, he wrote, appeared to be operated with great economy. He was refused admittance to the workings, and could gain no information from the officials at the mine. In the short time that he was allowed to remain there he saw natives sorting great lumps of yellow and gray-brown ores rich in radium. Their only tools were sieves and large shovels. The cost of labor, he thought, could not be more than $5 a week per man. He estimated that the cost of raising the ore to the surface was approximately 75 cents a ton, and transportation to the nearest railroad less than $1 a ton. The ore is shipped thence to the west coast.

Supposing the cost of mining to be $250 per ton, it would be small in proportion to the price of the radium yield, Dr. Guest believes. He questions whether the subsequent cost of crushing and crystallization processes amount to as much as $2,500 a ton. Even that cost would leave a tremendous profit. During 1929 this mine is reported to have produced 60 grams of radium, which at present American prices would have a value of more than $4,000,000. Dr. Guest learned that radium has been produced in Great Britain from imported ores of inferior radium content at a cost yielding a profit if sold as low as $25,000 a gram.

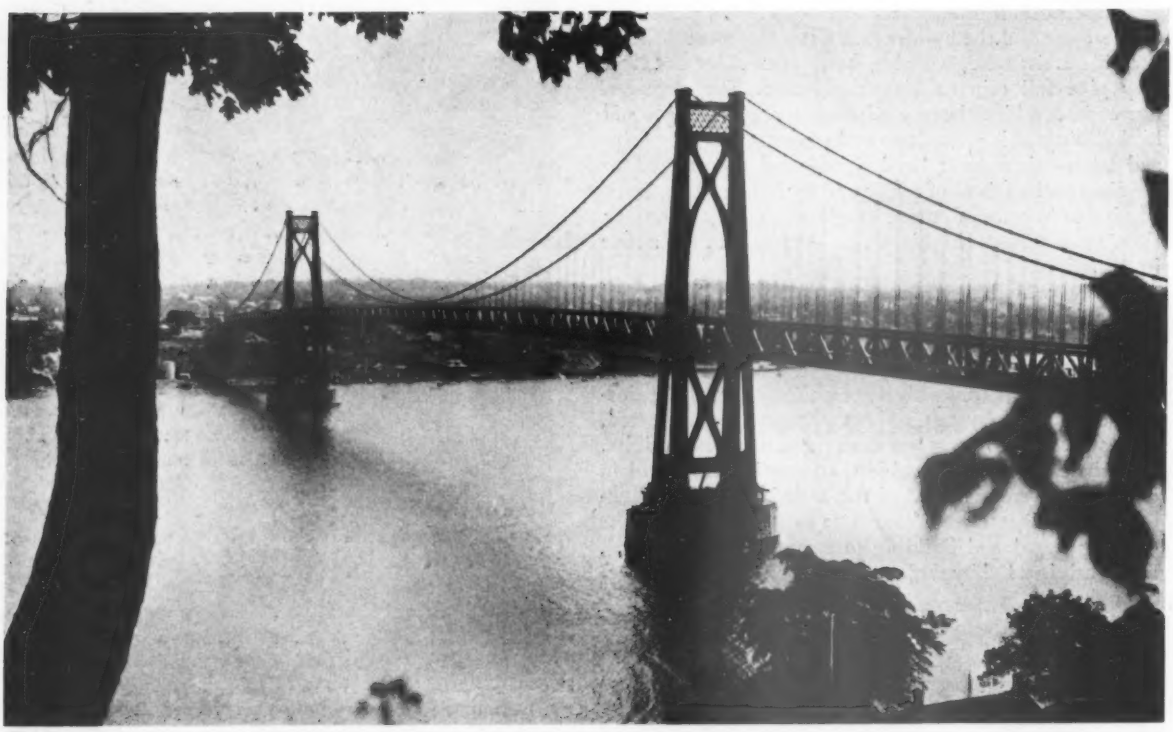
The methods of extracting radium vary, but the outline of the process worked out by Madame Curie consists of five steps. These include getting the uranium mineral in solution, separating from the solution all metallic sulphates which are insoluble in water (these include the whole of the barium and radium constituents of the mineral). The next step is the conversion of the sulphates into double salts, purification of the compound of radium and barium, and finally separating the radium from the barium by a process of fractional crystallization.

As a result of his investigation, Dr. Guest thinks that because of the great value of radium in the treatment of disease, particularly cancer, the world might well demand publication of the costs of producing the mineral.

"Magnificent Creators of Unemployment"

AS IF in answer to Stuart Chase's appeal in the November Review for an awakened consciousness in the *engineering mind*, we read that the executive imagination of this "most important group in the modern world" has been aroused to a realization of its professional responsibility and is planning a study of the underlying causes of technological unemployment. The psychological implications of unemployment in its relation to society are fully discussed in the article by Mr. Bakeless, "Machine-Made Minds" (page 275).

It is interesting to notice that engineers as a class have now publicly announced their determination to study the situation as indicated by a report of the American Engineering Council, representing 59,000 professional engineers in all parts of the (*Continued on page 308*)



MID-HUDSON BRIDGE CONNECTING POUGHKEEPSIE AND HIGHLAND, N. Y.

BOOKS

Scientific Book Club Selections

BY special arrangement with the Scientific Book Club, Inc., The Review is to present each month a list of books selected by that body as meriting the careful attention of all who desire to keep abreast of scientific thought. The selections are made by an editorial committee consisting of Arthur H. Compton, Edwin G. Conklin, Kirtley F. Mather, Harlan T. Stetson, and Edward L. Thorndike.

For February the principal selection was:

THE SCIENCE OF LIFE, by H. G. Wells, Julian Huxley and G. P. Wells. $10.00. 1,514 pages. Illustrated. New York: *The Scientific Book Club, Inc.*

"'The Science of Life' is conceived in the broadest possible sense. The book embraces not only the entire field of biology, but also of historical geology, the physiology of man, animals and plants, human and animal psychology, the philosophy of evolution and even makes a brief excursion into the realm of spiritualism. . . . It may be said that the book begins and ends with man, and that all that lies between is 'humanized knowledge.' Its sweep and scope are so great that principles and details appear in their proper proportions."

Other highly recommended books obtainable from the S. B. C. are:

ZEPPELIN, by Margaret Goldsmith. $3.50. 278 pages. Illustrated.

AVIATION OF TODAY, by J. L. Nayler and E. Ower. $6.00. 491 pages. Illustrated.

THE NATURE OF LIVING MATTER, by Lancelot Hogben. $5.00. 316 pages.

HUMAN LEARNING, by Edward L. Thorndike. $2.50. 202 pages. Illustrated.

Government in a Technological Society

THE AMERICAN LEVIATHAN, by Charles A. Beard and William Beard. $5.00. vii + 824 pages. Illustrated. New York: *The Macmillan Company.*

IN AN article, "Machine Age Politics," in the January Review, the Beards by example and inference demonstrated that the social environment of government has been revolutionized by steam, electricity, machinery, and science. Not only has the environment been vastly changed, but the "technological revolution has thrust itself into all the institutions and practices of government. It has emphasized as never before the rôle of government as a stabilizer of civilization." This article might well stand as a prolegomenon to "The American Leviathan" (even though the writing of the book preceded the writing of that article) for it constitutes an admirable preliminary statement for the book.

This technological drive in government, which is the central idea around which the Beards build their book, is too little realized in our political thinking, granting that such thinking exists in America. The rank and file of the American people still conceive of their government, founded in an agricultural era, in the light of that era. A majority of the politicians, busy with their pastoral politics, and lulled by their bucolic musings, view the scene about them with the naked eye of the Eighteenth Century, oblivious to the fact that they can only see it correctly by using the fine instruments of the Twentieth Century.

While they muse, however, government under the pressure of forces originating in the laboratory and in the minds of technicians, has become an economic and technical business on a tremendous scale. "Fortunately in introducing these bewildering complexities into government," write the Beards, "technology has brought with it a procedure helpful in solving the problems it has created; namely, scientific method. . . . Though undoubtedly limited in its application, the scientific method promises to work a revolution in politics, no less significant than that wrought in society at large by mechanics. It punctures classical oratory — conservative as well as radical — and offers to explore worlds unknown to politicians of the archaic school. Recognizing the demands of a new order, a United States Senator, Elmer Thomas of Oklahoma, has proposed an official reëxamination of our whole traditional system of government in the light of the changed situation."

It follows that the scientist-engineer is called upon to play an increasingly important part in this new political situation. That he has not done more is the result of his willingness to play the part of the hired man — he is Prometheus enchained as Mr. Stuart Chase expressed it in a recent article in this magazine. If the scientist-engineer is to make his due contribution to the efficiency of our governmental machinery, he must recognize his importance in the new order of things and insist that the government utilize the competence and expertness that is necessary to cope with the complexities of the Machine Age.

All of these things are thrown into bold relief in this new book on American government. It reviews in detail every aspect of our political economy and illuminates the many dark and dubious corners of the political structure. And it is done with the trained, scholarly, competent manner that has characterized the previous books from the pens of the Beard family. Not quite as stirringly written, perhaps, as the "Rise of American Civilization," it is presented in a manner appropriate to the subject. Engineers and scientists, no less than other folk, will find it valuable for reference, stimulating to read, and worthy of study.

It is interesting to note that the bibliographical note at the end of the book contains not only references to a host of books, pamphlets, and articles, but a list six pages long of educational films which throw light on the functions of government. So far as I know this is the first time that motion picture films have been organized with reference to a particular study and have been consulted in making that study.

J. R. K.

The New Life Members

LAST month The Review announced the election of Messrs. John R. Macomber, '97, Albert H. Wiggin, and Alfred L. Loomis as Life Members of the Corporation. All three of these men have won high places in the business world (Mr. Loomis in the legal profession, also) and are well known in their respective fields. But what of their extra-curricular activities, so to speak? For the purpose of answering this question the following sketches have been prepared:

John R. Macomber, '97

Mr. Macomber is a man of strong enthusiasm, great energy, and simple tastes. He is active in a wide variety of interests and is noted for his quick and decisive judgment of men and affairs. His name, long familiar in the world of business and finance, is equally distinguished wherever sportsmen gather. Like many other successful men, he has found relaxation in a hobby, and for years much of his leisure has been devoted to the breeding of thoroughbred horses.

Raceland, Mr. Macomber's private stables on his estate at Framingham, Mass., is one of the most complete and beautiful racing establishments of its kind. He has imported many horses from abroad, and from his stables have come many thoroughbreds that have distinguished themselves in racing. Mr. Macomber's interest, however, is not confined to racing alone, for he has given much of his time and means to the restoration and maintenance of those fine amateur sports in which horses play a part. He has been particularly active in a revival of country club racing and in horse shows, and is a celebrated host among American amateur sportsmen.

Of Mr. Macomber's many famous race horses, Petee Wrack, son of the famous Wrack, and handicap mile champion of America, is perhaps the most distinguished. He holds the distinction of being the only horse to defeat the brilliant Reigh Count, winning this victory in the Travers Midsummer Derby at Saratoga last year.

As Chairman of the Board of Directors and earlier President of Harris, Forbes & Company, Mr. Macomber is nationally known as a financier whose achievements have been born of long training and sound judgment. He began his career with the same company in 1894, and in 1916 became its president, a position he occupied until his election as Chairman of the Board of Directors a few months ago. He is a director in numerous corporations, including the Chase National Bank of New York; the First National Corporation and Harris Trust and Savings Bank, Chicago; Harris Forbes and Company, Ltd., Montreal; and he is a trustee of the Warren Institution for Savings, Bankers Investment Trust, Federal Street Building Trust, Massachusetts General Hospital, the New England Conservatory of Music, and the Society for Prevention of Cruelty to Animals, Boston.

When in 1921 Mr. Macomber was awarded the honorary degree of Master of Arts, the President of Tufts College, in conferring the honor said: "The tradition that business men and college men labor in separate fields happily is passing away. More and more, business is recognized as a profession. More and more the problem of education becomes a universal one. In recognition of the high standard of business ethics you have maintained as head of one of the largest and most representative financial houses in our city, in appreciation of what you have done as a member of the Chamber of Commerce of Boston, and in gratitude for the splendid work you did in the New England Liberty Loan Committee, I confer this degree."

Albert H. Wiggin

The Chase National Bank is the largest bank in the world, and Mr. Wiggin is chairman of its governing board. That is the most widely known fact about this new Life Member of the Institute's Corporation, with the possible exception that he is a leading American man of business who favors a reduction in inter-Allied debts. The latter fact was revealed in Mr. Wiggin's annual message to his bank's stockholders in January. Noted for being taciturn and not given to public proclamations, he speaks to the public only in his annual reports, making them events in the business calendar.

His 1930 annual report presents a survey of the present unfavorable conditions with the assertion that "we are approximately at the worst of depression" and that the next important move will be upward. Other suggestions of this important report are a modification of the tariff and a reduction in the capital gains tax from 12½ to 7½ per cent. As a leader in Wall Street, Mr. Wiggin is credited with directing a large portion of the banking effort to relieve financial stress.

His interests, however, extend beyond the world of banking, as his appointment to the Corporation indicates (he is also a trustee of Middlebury College). He has been called "the banker with a million friends," the newspaper reader who can "read all the morning papers in New York in no time at all. (And does.)" One of the distinguishing characteristics of this successful financier is his inscrutable expression, one that lends confidence to people with whom he has dealings, and one that has many times stood him in good stead. His well founded belief in himself has carried him safely over his misfortunes and led him to larger opportunities for displaying his talents.

Outside of his professional life, Mr. Wiggin considers his circle of friends of the utmost importance. In a magazine interview he expressed his personal opinion of the natural source of friendships. "Friends don't make a man, but if a man has the right qualities, the right caliber, he cannot help making friends; they just feel drawn to him." In order to gain his reputation of "the banker with a million friends," he must have possessed such qualities to a remarkable degree.

He is the son of a Massachusetts clergyman, is married, has two daughters, and homes in New York, Greenwich, Conn., and South Carolina. He is a collector of etchings and is fond of golf. He graduated from the English High School, Boston, in 1885, but did not go to college. During the war he was United States Fuel Administrator for the State of New York.

ALFRED L. LOOMIS

Mr. Loomis, a lawyer by profession, has probably the finest and most interesting private laboratory in this country. His own researches have dealt principally with physical, chemical, and biological effects of supersonic vibrations, with the development of ingenious timing and control circuits using modern radio and glow tubes, and with the accurate measurement of time. During the past two years he has kept a continuous automatic record of the time signals from Greenwich, the Eiffel Tower, and Annapolis, and checked them against the finest collections of pendulum clocks and chronographs which has ever been assembled. An additional check has been given by continuous records from the vacuum quartz oscillator of the Bell Research Laboratories in New York.

One of the interesting papers at the recent meetings of the American Association for the Advancement of Science, in Cleveland, was by Yale astronomers, and based on Mr. Loomis' experiments on the measurement of time. Peculiar cyclic anomalies in these time records are accounted for, at least in part, by a hitherto unsuspected action of the moon on pendulum clocks and on the figure of the earth, since the experiments are accurate enough to detect a distortion of the earth which changes by only a few inches the distance from the surface to the center.

Mr. Loomis has been very generous in inviting other scientists to share the facilities of his laboratories as his guests, and from time to time has arranged delightful week-end conferences in honor of distinguished foreign scientists, at which a hundred or so prominent scientists from all over the country have been his guests.

Last summer Mr. Loomis conducted an interesting experiment in the education of young men, designed to give promising boys, whose experience had been limited, an opportunity to learn about the nature and possibilities of careers in various fields. He designed some special touring cars, accommodating ten boys each, with complete sleeping, cooking, and transportation equipment. Each of these groups, under the direction of one of its number, made a tour of the leading industrial plants of the East and Middle West. This tour proved very successful and was carried out at a remarkably low cost per boy.

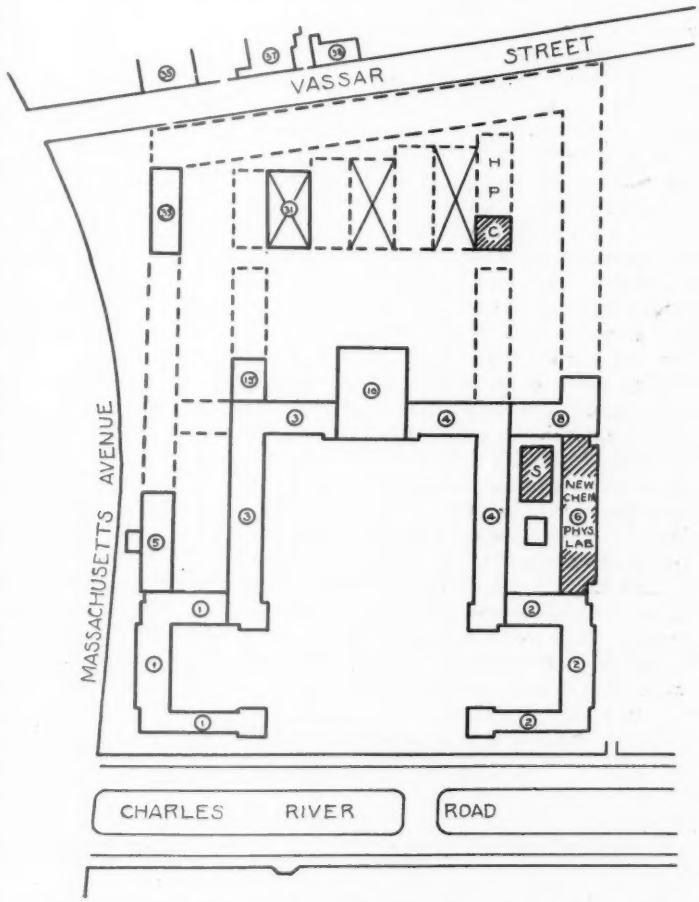
Mr. Loomis has been much interested in the affairs of the American Physical Society and particularly in its program for publication of research. He is also much interested in sports, having been associated, for example, with his brother-in-law, Mr. Langdon Thorne, with the *Whirlwind*, one of the five contenders in last summer's yachting races.

Because of his combined qualifications of lawyer, business man, and scientist, Technology has particular cause to welcome him as a member of the Corporation.

The 149th Meeting of the Alumni Council

THE major portion of the Alumni Council meeting in Walker Memorial on January 19, was devoted to a discussion of the report of the Committee on the Reorganization of the Alumni Association. This committee, composed of Charles W. Aiken, '91, (*in absentia*), Francis J. Chesterman, '05, Bradley Dewey, '09, Francis E. Stern, '16, and Allan W. Rowe, '01, had made a thorough study of the problems facing the Alumni Association, particularly that of nominating the Term Members of the Corporation.

"Since its organization," says the Committee's report, "the Alumni Council has elected a Nominating Committee whose function yearly has been to present a slate for the officers of the Alumni Association and a group of



THE INSTITUTE'S MAIN GROUP OF BUILDINGS. FULL BLACK LINES SHOW BUILDINGS ALREADY IN USE. CROSS-HATCHED AREAS ARE BUILDINGS UNDER CONSTRUCTION OR SHORTLY TO BE BEGUN. DOTTED LINES REPRESENT POSSIBLE FUTURE BUILDINGS. "S" IS THE SPECTROSCOPIC LABORATORY, "C" THE CRYOGENIC (NOT BEGUN)

candidates for Term Membership on the Corporation. Originally, these names were then sent to the Alumni Association in the form of a ballot. Voting on the officers was a perfunctory exercise as no choice of candidates was offered; initially six candidates were offered for Term Membership, of which the three with highest vote received the Corporation nomination. Experience demonstrated in the course of years that a number of defeated candidates were alienated from the Institute. To correct this condition, a number of years ago, the number of candidates for these positions was increased to nine on the pleasing theory that the individual share of the odium of defeat would be lessened thereby. This did not prove to be the case and a situation increasingly acute was thereby engendered. The number of Alumni voting on these matters has shown a steady decline in recent years, most recently less than 20% exercising the right of suffrage."

The new plan submitted to the Council by the Committee is designed to correct these undesirable conditions. In brief abstract the plan suggests that:

1. The present Alumni Council be dissolved;
2. A Boston Technology Club with a local Council to handle local affairs be organized;
3. A House of Delegates be established, the members and their alternates being elected by local divisions of the total Technology group, determined on a population basis;
4. The House of Delegates consist of (*with vote*) President (in case of tie only), Vice-President, 15 delegates, and five past Presidents (most recent), totaling 22; and (*without vote*) Secretary (elected by Corporation), Treasurer (from The Technology Review), 15 alternates, 15 Term Members of the Corporation, totaling 32.
5. All major functions be vested in the House of Delegates such as election of officers, nomination of Term Members to Corporation, nomination of Alumni Secretary, amendments to Constitution and By-Laws, election of Standing Committees, and similar major items of business;
6. An Alumni Secretary be elected by the Corporation for a term of five years.

The report was presented to the Council by Dr. Rowe and it elicited a vigorous discussion. Points raised in objection included: (1) That the classes, the most reliable Alumni units, would have no representation. (2) Doubt as to the possibility of getting delegates to attend meetings. (3) Disagreement with the geographic groupings tentatively suggested in the report. (4) That the present Alumni Council is functioning properly and will be more efficient than the proposed House of Delegates. (5) That the present system is functioning so well that no change seems necessary. These and other minor objections were raised to which Dr. Rowe made detailed and admirable rebuttal.

The offshoot of the discussion, which was one of the longest in the history of the Council, was a vote that the Reorganization Committee be highly commended for its work and that the report be carried over for further discussion and possible final action at the March meeting of the Council. During the discussion letters were read from the St. Louis and Louisville Clubs, and other representatives who had communicated with their groups presented their opinions.

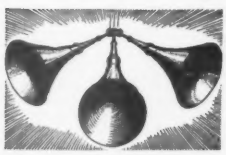
Next to the discussion of the reorganization report, the most notable item on the program was the report of the committee appointed to determine the official M. I. T. colors. This committee was appointed in 1926 and its report had been eagerly waited for several years. The members, Samuel P. Mulliken, '87, (Chairman), Allan W. Rowe, '01, Charles Bittinger, '01, and Arthur C. Hardy, '18, made a thorough study and the report which incorporates their findings is a first-rate scientific document. The exact shades of cardinal and gray were scientifically determined and a formula developed by which these colors can be reproduced in the future without variation in shade. This is believed to be the first time that an educational institution has made its official colors the subject of scientific research. The Review expects to publish in a future issue an extensive article on the work of this committee.

Other items on the Council program included a talk by Richard H. Ranger, '11, President of the Technology Club of New York, on the Alumni Seminars initiated by his group. Two new Council members, Henry D. Jackson, representing the Class of '05 and John A. Lunn, '17, representing the New Haven group, were announced. President Desmond outlined plans for the Annual Dinner on February 28 and Professor Leicester F. Hamilton, '14, explained the details of the Annual Dormitory party on February 13, to which members of the Alumni Council and their lady friends were invited to attend. Professor Samuel C. Prescott, '94, presented his report on the recognition of contributors to the Dormitory Fund Campaign. This report in its complete form, he announces, is not to be made public until after the February meeting of the Council.

President Compton was present and spoke briefly at the end of the meeting. He called attention to two notable pieces of work now going on at the Institute; one educational, in the form of a study by the Committee with Professor Prescott as Chairman, to improve and simplify the second year curriculum; and the other physical, involving a downward movement in the excavation for the new physics and chemistry building. Sixty-eight members and guests were present at the meeting.

"Louder... louder!"

--- a cry of the past—



Straining forward to hear the speaker they were all ears and he was all lungs—but still they couldn't understand him. No wonder "louder please"—and remarks less courteous—were bywords at old time gatherings.

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MACHINE-MADE MINDS

(*Continued from page 278*)

of machine society, a competition due to the overproduction caused by our failure to control the machine.

It is time to strike a balance, and granting that our minds are in large measure undeniably machine-made, to ask ourselves how far the machine's control over us is a danger calling for vigorous resistance; and how far it is a good thing, to which we may willingly yield. No doubt the chief danger the machine brings with it is the heavily disguised blessing of mass production. An admirable technique for the creation of motor cars, tractors, and safety pins, this is somewhat less desirable in the realms of imagination and ideas. Mass production, nevertheless, intimately affects these realms through the huge advertising campaigns needed to make mass markets for mass producers, which have naturally created the mass magazine with a circulation of one or two million.

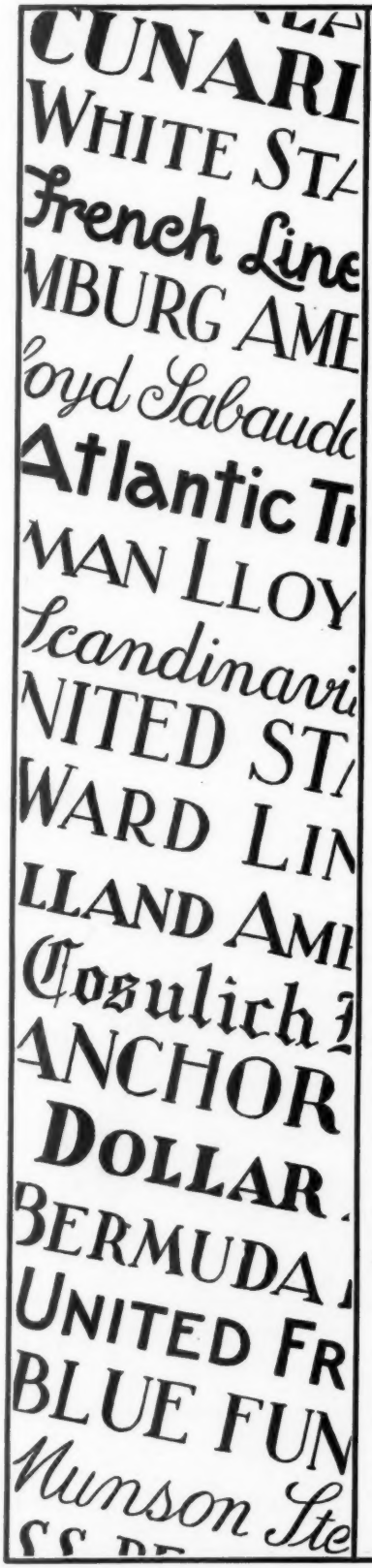
The whole mass system militates against vigorous and provocative thought and against vitality or intellectual honesty in letters. The mass magazines dare not offend mass prejudices. The contemporary writer, therefore, is held down to the taste, not of the lowest element of the population, which has no purchasing power, but to the level of prosperous mediocrity. That may not be a dead level, but it is certainly not a very live one.

The same thing is true of books, especially now that we have the one dollar "drug store book." It is glaringly true in the movies and talkies, where a producer knowing that he must spend four million dollars on a film is forced to keep to a level of taste which four million people can share. It applies to radio, which seeks about the same audience as the mass magazine. It scarcely applies to the phonograph, which is slowly doing for American musical taste what mechanical reproduction of paintings may yet do for art.

THE danger is that our minds may be tied down to the machine. Our art may some day be restricted (as advertising art has always been) to that capable of mechanical reproduction, our music to the requirements of radio, talkie, and phonograph (sopranos have a bad time in the talkies, hence, the future may listen to altos only), and our philosophy watered down to satisfy the enormous audience of Mr. Will Durant. All because we have misused the machine, or allowed it to misuse us.

There are even contemporary biologists who tell us that the ordinary processes of embryology will one day be superseded, and that babies will one day be mechanically produced in glass bottles in a state laboratory! This is not very sound biology (to put it mildly) nor even very scientific speculation (if any speculation is ever scientific); but it shows at least the direction in which the modern mind is working.

In creating the manifold perfections of the modern newspaper, the machine has very nearly destroyed the *raison d'être* of all decent journalism — the free expression of free opinion. Machines are so expensive that the machine-made press is necessarily controlled by a few very wealthy men, who with the very best intentions in the world are still subject to human limitation and the prejudices of their kind. (*Concluded on page 300*)



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MACHINE-MADE MINDS

(Concluded from page 298)

The day has gone by when anyone with five pounds and a printing press could state his views. The day is over, therefore, when it made sense to talk about a free press. The old newspapers were very much worse than the modern ones in most respects. But, at least, an unpopular truth had a chance of expression. Today the man or the government that controls two machines — wireless and cable — can control the ideas and passions of a continent. The hysteria of propaganda was well known to Peter the Hermit and Oliver Cromwell. But never in the reign of any despot was it so easily manipulated from a few central stations. Never did the propagandist escape so easily from checking and correction as he has since the Iron Despot settled firmly in his factory throne.

I BEGAN this article by saying that I had no intention of indulging in anti-mechanical Jeremiads, an assertion on whose veracity the last few paragraphs might cast a reasonable doubt. Still, we can hardly hope to use the machine as a liberator until we have frankly faced the fact that it may become a tyrant. Even as a despot, the machine is benevolent; and it is after all our stupidity that permits inanimate iron to be a despot at all.

It is fairly clear that the machine, however it has debased some arts, has given new life to others. The first really new architectural idea for generations, the columnar skyscraper, is the direct outcome of machine technique. The moving picture has always hovered on the verge of becoming an art. Its failure is surely the result of human rather than mechanical limitations.

If the world ever realizes the hitherto Utopian vision of a general diffusion of the good things of life — an ample assurance of food, clothing, and shelter for everyone, to which is added leisure for art, letters, pure science, and philosophy, the gorgeous playthings of the mind — it will have to look for them to the machine. That is, it will have to look to the machine for the economic basis on which these things must inevitably rest.

The great cultural hope which the machine holds out is the possibility of increasing leisure. Just at present, unfortunately, it is creating unemployment, which is a very different thing. Nevertheless, mental life of any really high kind is a matter of leisure well used. And leisure, as Aristotle saw, can exist only if somebody does the dirty work — only, in other words, on a basis of slave labor. In his Greece, as in our own old South, leisure existed on a basis of chattel slavery. For the last century it has rested on a basis of wage slavery. We now see the hope (as yet it is little more) of a general leisure, based on the slavery of the machine.

Strangely enough, we have hitherto been willing to enslave ourselves to the machine instead of enslaving it. Most of our contemporary troubles arise from that odd willingness to allow the machine to be master instead of slave. If we are to build a great civilization in America, if we are to win leisure for cultivating the choice things of the mind and spirit, we must put the machine in its place.

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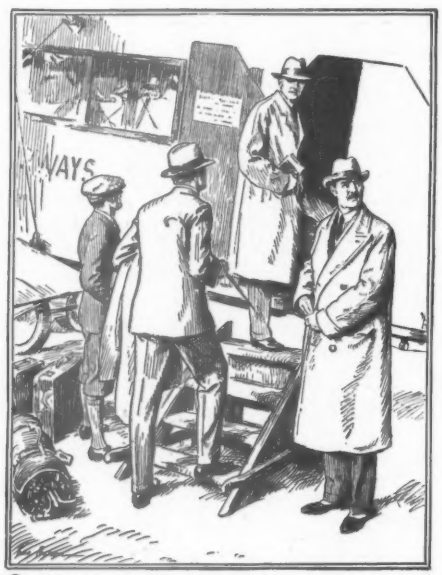

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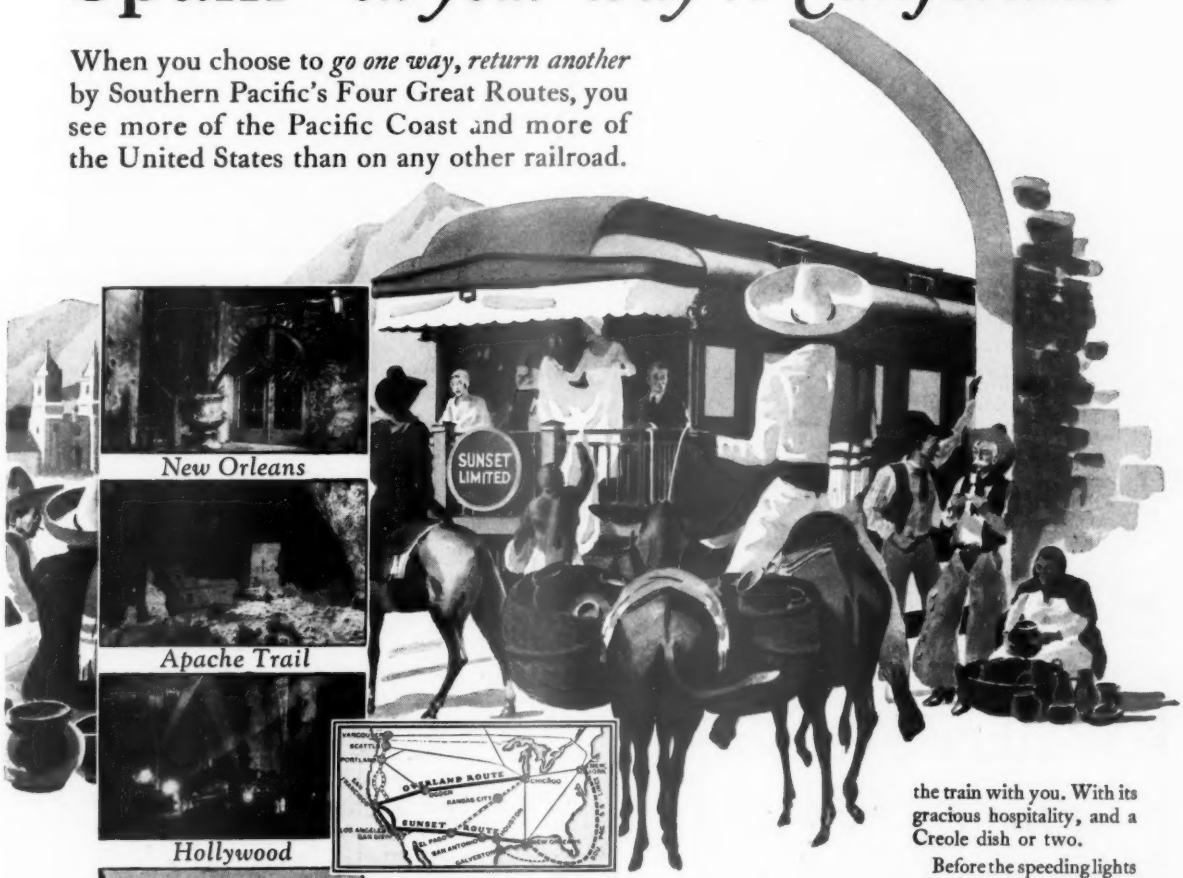

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FIFTY PFENNIGS' WORTH

(Continued from page 281)

In the department of optics are original instruments by Frauenhofer and Kirschoff and demonstrations of the measurements of velocity and intensity of light, refraction, diffraction, and polarization with interesting demonstrations of mirrors, prisms, and lenses. Optics begins with a study of the eye and shows original instruments by Helmholtz (the telestereoscope, phakoscope, and ophthalmoscope). In another alcove are stereoscopes with diagrams showing the theory of colors and color contrast effects; microscopes, telescopes, with an original telescope by Frauenhofer with which the planet Neptune was first seen in 1846. A whole room is devoted to the development of projection apparatus and cameras, while adjacent rooms are devoted to telephotography, television, and acoustics.

One of the most beautiful rooms in the whole building is devoted to music with instruments ranging from the crude rattles and drums of savage tribes to the various wind, string and keyboard instruments; from the simple lyre of antiquity to the modern pipe organ and grand piano, both manual and mechanical. Skilled musicians give demonstrations on the various instruments daily to large and interested audiences.

In the department of chemistry much space is given to early developments. A vaulted Gothic room shows an alchemist's laboratory of the Sixteenth Century. From this to the iatrochemical period with its herb garden and distilling-plant is but a step, and beyond that is displayed the apparatus used by Boyle and that used by Priestley, Cavendish, and Scheele, in the "phlogiston theory" period. There is a copy of Lavoisier's experiment of analyzing water, with reproductions of other apparatus by Lavoisier, Liebig, Berzelius, Wöhler, and Bunsen. The different cases showing modern chemistry demonstrate fundamental principles and modern chemical apparatus for analysis and synthesis, with demonstrations of reactions, spectrum analysis and so on. A large central case is devoted to a collection of the elements.

Inorganic chemistry shows the industrial production of nitrates, nitric acid, sulphuric acid, sodium carbonate, and so on, in ancient and modern times. It shows the development of electrical furnaces and a large replica of a Haber-Bosch plant producing ammonia sulphate. Organic chemistry shows products formerly secured from plants but now produced by synthesis, the relations between raw products and the finished products of industry and on a long wall a ten-foot high "family tree" of coal tar products.

An entire wing is devoted to building materials and buildings, starting with woods, their structure and employment; natural and artificial stones; ceramics and glass and their manufacture and use. The models of buildings start with the primitive caves and carry on through timber and masonry buildings, and even go into the fascinating field of town planning. It takes up the evolution of lighting from the pine torch to the latest developments in electricity. With these are graphical demonstrations of heating, refrigeration, water supplies, sewage, plumbing, gas, and electrical engineering.

(Continued on page 304)

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FIFTY PFENNIGS' WORTH

(Continued from page 302)

The department of astronomy contains planetaria of the Ptolemaic and Copernican systems. The Ptolemaic planetarium has a projecting apparatus with 119 lenses and throws the image of the star-sprinkled sky on a dome 30 feet in diameter, and also shows the movement of the heavenly bodies at any desired speed. The Copernican planetarium, in a room 40 feet in diameter, is a movable model of the solar system, in which the observer is carried in a cage in a path representing the earth's orbit. There are many astronomical instruments including an original 15″ Frauenhofer telescope and a 400 M. M. reflecting telescope by Goerz.

The textile industry of New England would be particularly interested in the next eight rooms, in which are housed the textile exhibits, showing first the various textile fibres like flax, hemp, jute, china-grass, cotton, wool, camel's hair, silk, metal filaments, and artificial silk; then the work preparatory to spinning, including cleaning, opening, carding, combing, drawing, roving, and so on. Following this is a collection of machines — hand spindles, spinning wheels, spinning machines, and the Crompton mule jenny of 1775. Here we find the original of the oldest German spinning machine, with 60 spindles. Then there are machines showing the preparation of flax (throwing, breaking, and hackling). A whole room is devoted to the weaving of plain and fancy goods (Jacquard), while the next three rooms show, first, the development of the sewing machine; second, the finishing of textile products including dyeing, and third, the analyses of fabrics with testing apparatus.

Such is a partial account of the activities of the museum. The thing that impressed me most was that I, myself, unhindered, was allowed to operate so many machines and that the cutaway models showed so much of the interior mechanism that understanding was easy. One was led — even tempted — from one exhibit to another; study was play.

Munich is a city no larger than Boston, but it contains nearly 40 museums of all kinds. Some, like the Glyptothek, the Pinakothek (old and new) and the Residenz Museum, are known the world over in the field of art but the Deutsches Museum is in a class by itself, for it not only tries to please the public but its real effort is to educate it; to so arrange a system of exhibitions that every branch of science may be studied as well as popularized. To this end the Museum retains a group of scientists to study arrangement and a body of teachers qualified to take groups of students through the various departments and to accompany a visiting scientist interested in the latest developments of his specialty. The school children throughout Germany are taught of its wonders and especially interested students are sent to Munich to study in the Museum and to come back with reports of what they have seen. The Museum has a million visitors a year, ranging from all the school children of Munich to large lecture groups.

No paper about the Museum would be complete without an appreciation of Dr. Oscar von Miller, the founder and developer of the Museum. With unending enthusiasm and skill he interested the heads of the steel, chemical,

shipping, mining, and machinery industries; he interested the emperor, kings, dukes, scientists, municipalities, and general governments until he brought together not only the Museum, but a working body of interested and able executives. You may have noticed that even Henry Ford recently fell under his spell and gave the Museum 1,000,000 marks.

Dr. von Miller, although aged, is still working. The next unit of the Museum, the library, is about half completed. It will give the student up-to-the-minute information of any technical subject and will be of the greatest use to the able scientists that plan out the Museum and transmit their knowledge to the public. A recent newspaper item mentions Dr. von Miller as now busy in planning a unified electrical power supply for Germany, linking up the brown coal mines of Bitterfield with the great industrial centers, from Cologne and Ruhr in the west to Berlin and Leipzig in the east — all on a circular high tension line, touching all important power sources and distributing this power to every city, town, and village of Germany. Such is the man who has created the Deutsches Museum.

Industrial museums are not new to Europeans. The Conservatoire des Arts et Métiers in Paris was founded in 1799, and its first collections were simply the gathering together in the old priory of Saint-Martin-des-Champs, of the collections of royal times made by Vaucanson and the old Academy of Sciences. In England the remains of the collections of the Crystal Palace Exposition of 1851 were gathered together in the dusty, temporary buildings of the South Kensington Museum, but it was not until 1924 that the new Science Museum on Exhibition Road was opened to the public.

Here in the United States a belated but promising start has been made in developing technical museums designed to serve Americans as the Deutsches Museum has the Germans. Through the generosity of Julius Rosenwald, Chicago will in another year have such a museum housed in the reconstructed Fine Arts Building of the 1893 World's Fair. Philadelphia is working out the details of a museum to be associated with its Franklin Institute, while Washington is petitioning Congress to start one there. Much material is already available in the old Smithsonian Collections and Patent Office archives. New York already has a small museum — the Museum of Science and Industry now housed on the fourth floor of the News Building (See The Review for February, page 240), while little Doylestown in Pennsylvania has one of the earliest and most interesting industrial museums, founded by Henry Mercer. In Dearborn, the Henry Ford's museum is almost completed. It promises to be one of the most interesting and instructive places in the world with material garnered from everywhere.

It is significant to note that the original charter of Technology provides for the establishment of a museum in conjunction with the Institute. Certainly Technology could have no more fitting and tempting addition. I am tempted to say that it might dispense with half of the Faculty, should it have one. As a matter of fact, it would probably cause the Faculty to be doubled. The Institute already has here and there models and machines that would form an admirable nucleus of a museum which in our New England might at first be (*Concluded on page 306*)

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FIFTY PFENNIGS' WORTH

(Concluded from page 305)

limited to textiles and to the graphic arts and then expanded as the opportunity offers. I know of no way in which the Institute can be of greater service to the public than by establishing the museum provided for in its charter. It only remains to find an American Oscar von Miller.

Now do you wonder that the honeymooners stopped three days in Munich to see the Deutsches Museum, when all this can be seen for 50 pfennigs?

LIGHT FROM DARK PLACES

(Continued from page 285)

are gathering information for text books but are contributing widely to industry and to human welfare and happiness.

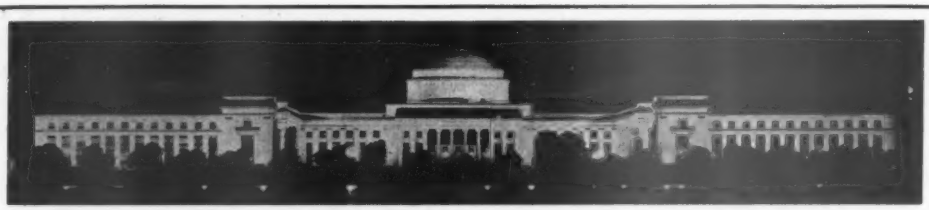
In some of this work it suffices to place materials in an arc and then photograph their spectra in the conventional manner. But often it is necessary to determine the spectral pattern under particular conditions which last for only a small fraction of a second, as, for example, just after the arc is lighted or perhaps immediately after the current has been shut off. It is even better to obtain a series of spectrograms taken at intervals of a thousandth of a second or much less, in order that the growth or decay of the spectrum can be studied, for changes take place rapidly during these periods. Of course, an ordinary photograph of the spectrum made, let us say, by opening the shutter just as the arc is lighted and closing it one-tenth of a second later, may indicate that changes have taken place during the lighting process. But the analysis of the spectrogram would be about as fruitful as the examination of a one-tenth second exposure photograph of the press during the printing of this page. Evidently at this stage the spectroscope's eyepiece needs to be replaced by a high speed motion picture camera.

REALIZING the limitations of existing spectrographic equipment in this respect, at least three motion spectrographs have been constructed, the last one having been built recently in the Institute's Physics Department shop. These have made it possible to analyze the course of a spectral process occurring in a time so brief as to be almost beyond our powers of conception. In fact, in one case in which the film was not moved as it is in the ordinary motion picture camera, but was held fixed in a curved position around a rotating mirror, spectrograms were made at the rate of a million per second.

The source of radiation must be extremely bright, however, to permit making exposures in a millionth or even a thousandth of a second. Unfortunately, most sources are not so bright; in extreme cases an exposure of several hours' duration is required for each spectrogram. The method cannot, therefore, be used without modification.

The modification introduced at the Institute consists in causing the spectral process to repeat itself many times, over a period of hours, if necessary, and in passing the film through the camera again and again, always in synchronism with the process. This is accomplished very simply by clamping the film to a metal drum rotated by a synchronous motor, and by controlling the spectral emission by the same alternating current which operates the motor. With this combination, although 15,000 spectra are photographed every second, at the end of six or 60 hours — the length of time does not matter — both the camera and the source of radiation are still in step. We find a parallel state of affairs in modern electric time keeping; our synchronous clocks remain in step with the power house generators indefinitely. Because of the synchronization, the elongated spectral lines, which may be considered as being composed of the individual photographs placed end to end without breaks between them, begin and end with the same sharpness as though the drum had made but a single revolution.

As an extremely simple example of what has been studied with the aid of this apparatus, the following may be cited. The tungsten mercury arc, as many of us know, emits not only the line spectrum characteristic of mercury atoms, but a considerable amount of continuous radiation in addition. It is reasonable to suppose that a part of the latter originates in the surfaces of the hot tungsten electrodes, but since an electrical discharge through hot mercury vapor can also produce continuous radiation, there may be some question as to what part of it is due to each cause. When the arc is operated on a 60 cycle alternating current, the excitation of the mercury vapor approaches zero every 120th of a second, and therefore the continuous radiation due to the vapor must practically disappear periodically. The electrodes, however, have such high heat capacity that their temperature remains nearly constant at all times, and consequently their radiation cannot decrease noticeably during the



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current reversals. It is necessary only to take a motion spectrogram, like the one shown at the top of page 285 and then to note whether or not any part of the continuous radiation is present at all times.

Perhaps the greatest use for motion spectrograms is to be found in the study of excitation and recombination phenomena. When atoms of an element are bombarded by a stream of electrons moving sufficiently fast, things begin to happen to their internal arrangements of electrons. Because the nature of the disturbance is evidenced by the pattern of the resulting spectral lines, much interesting information concerning the processes occurring within the atoms can be obtained indirectly from spectrograms provided that they are made at the correct instants. The chief difficulty encountered in ordinary methods of spectroscopy lies in the fact that it is often impossible to maintain atoms in certain of these disturbed states for a sufficient length of time to permit observation. Fortunately, however, the atoms can be made to pass through these same conditions as often as we please, and therefore their behavior can be studied with the aid of motion spectrograms even though very feeble radiations are emitted at each stage of the process.

Our knowledge of the internal affairs of atoms and molecules is growing so rapidly that one may rightly begin to question what the research spectroscopist of the future will find to occupy his attention. There is, however, no danger of saturation, for even perfect familiarity with the structure and habits of atoms may be predicted to be a mere beginning, just as Newton's discovery marked the birth of spectroscopy. And if we can count so many advances resulting from one simple addition to the world's knowledge, what must be the consequences of the numerous present day contributions!

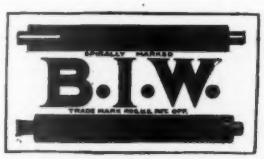
REVOLUTIONARY AVIATION

(Continued from page 283)

downwash from the rotor, and the propeller torque would upset the attitude of the ship.

The helicopterists have not been slow to borrow from the success of their rivals. Corridino D'Ascanio recently completed some very successful flight tests near Rome. His blades, two pairs rotating in opposite directions, are driven in flight from the engine, but they are free to rise and fall and with the engine cut off, function autogirically. An ingenious system of three little adjustable propellers driven from the blades, not from the engine, gives control about the three axes of the ship at all times. Possibly these would be a fair return to the giro people. He was able to ascend 50 feet, stay up almost nine minutes, and complete a closed circuit of over 3,000 feet, which is certainly the best practical helicopter performance to date. The Pope has ordered three of these for the Vatican City because there is not room for a large airport.

It is of course difficult at this time to estimate the true value of these aircraft. The extensive development and use of the autogiro in private flying and in transport should result in decreased fatalities and increased utility. There seems to be no immediate prospect that they will also solve the equally important problem of production and operating costs.



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THE TREND OF AFFAIRS

(*Continued from page 292*)

United States. Mr. McClellan, former Dean of the Wharton School of Commerce and Finance of the University of Pennsylvania and a member of President Coolidge's Muscle Shoals Committee, described the engineers as "the magnificent creators of unemployment" and further pointed out their duty to find a solution for the problems for which they were primarily responsible, suggesting a continuing inquiry into the causes of depression by a permanent body rather than a one- or two-year study.

The organization of this permanent staff is to be modeled along military lines and requires the coördination of government and private agencies. The staff should include representatives of the national associations: bankers, investment bankers, the Federal Reserve Board, manufacturers, real estate boards, Federation of Labor, Research Council, Bureau of Economic Research, and utility and railroad associations.

The seven points of attack recommended in the report are:

"Maintaining or increasing the consumption of goods and services; balancing plant machinery, and processes against production demands; balancing distribution agencies against consumer requirements; balancing manpower against production and distribution demands; controlling money and credit to satisfy the needs of government business, and the individual; encouraging research activity to increase human well-being through development and progress in industry and business; balancing public works against public need."

In line with the activities of the American Engineering Council, the Engineering Foundation is sponsoring research projects in science and the humanities, thus extending the sphere of their usefulness to include the human side of engineering. This study is to be undertaken in an effort to meet more adequately "the engineer's obligations in the upward progress of humanity."

"Among engineers and the public the conception of the obligations of the engineering profession is broadening to embrace the sociological together with the material aspects of the applications of the sciences through engineering and other branches of technology," according to the report read by Chairman H. Hobart Porter, President of the American Water Works and Electric Company.

Before initiating this program, preliminary studies are being made of the placement of graduates of technical secondary schools and colleges and special attention is being given to the maladjustments of this group in society. It is evident from these two reports that the engineers are at last taking definite steps in the right direction.

(*Concluded on page 310*)

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THE TREND OF AFFAIRS

(Concluded from page 308)

The technical research program Engineering Foundation includes a two-year investigation of the effects of high temperatures on metals by the American Society of Mechanical Engineers and the American Society for Testing Materials. Other technical studies will be an investigation of pure iron electrodes and research on the flow of concrete under sustained loads, the alloys of iron, blast-furnace slags, fundamental properties of dielectrics and wood-painting.

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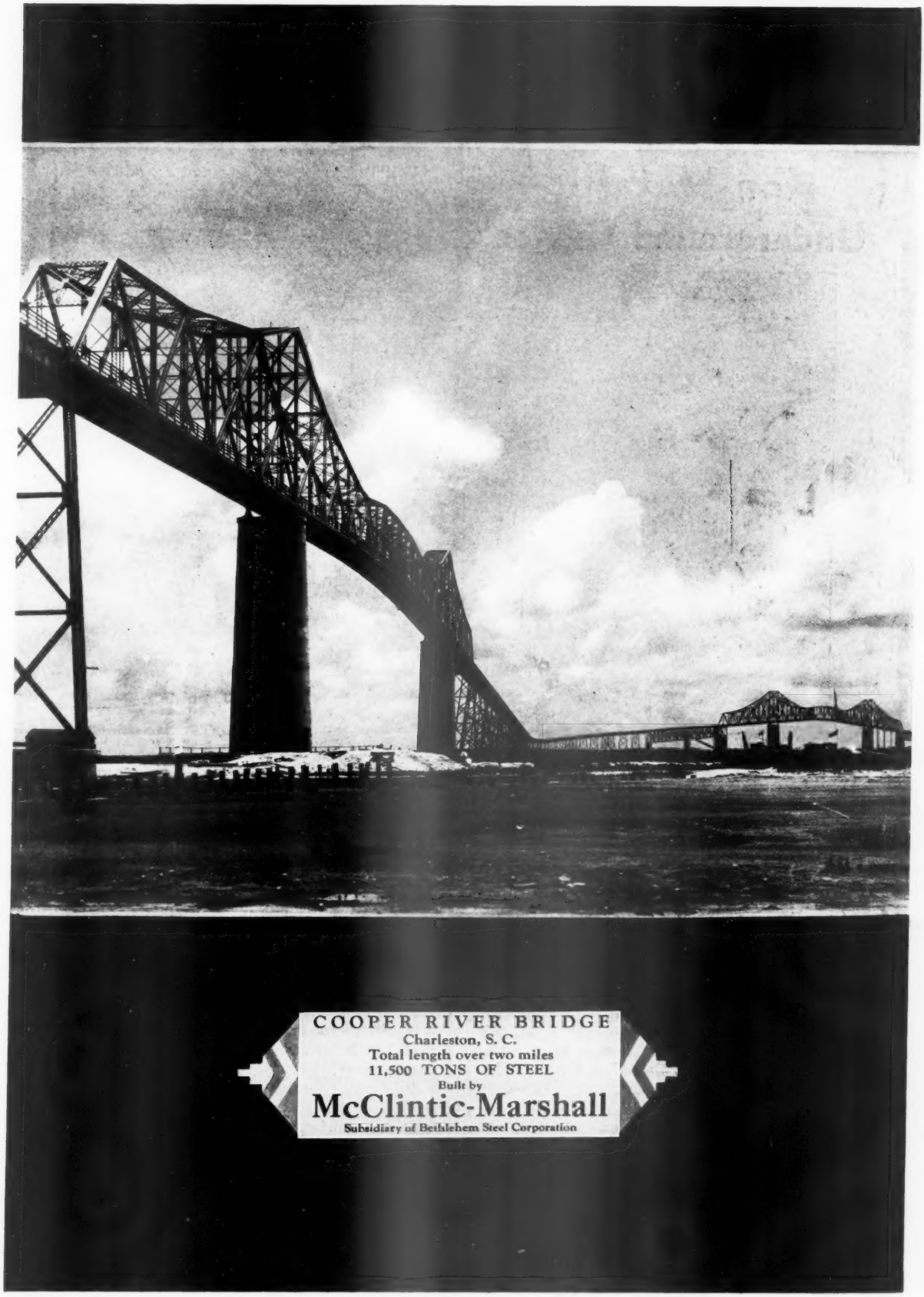

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THE TABULAR VIEW

SOMETIMES the layman is not as gullible as many pseudo-scientists think he is. The following bit of light verse from the Manchester *Guardian*, laughing gently but effectively over an absurd statement, is a point in evidence:

HOW TO BE A HERO

"When a man distinguishes himself in face of great danger or in a sudden crisis he is under the influence of a substance called adrenalin, which flows from the adrenal gland into the blood. Heroes are simply people with enlarged adrenal glands. This adrenalin can be made in the laboratory by the distillation of coal tar." — From a class room lecture.

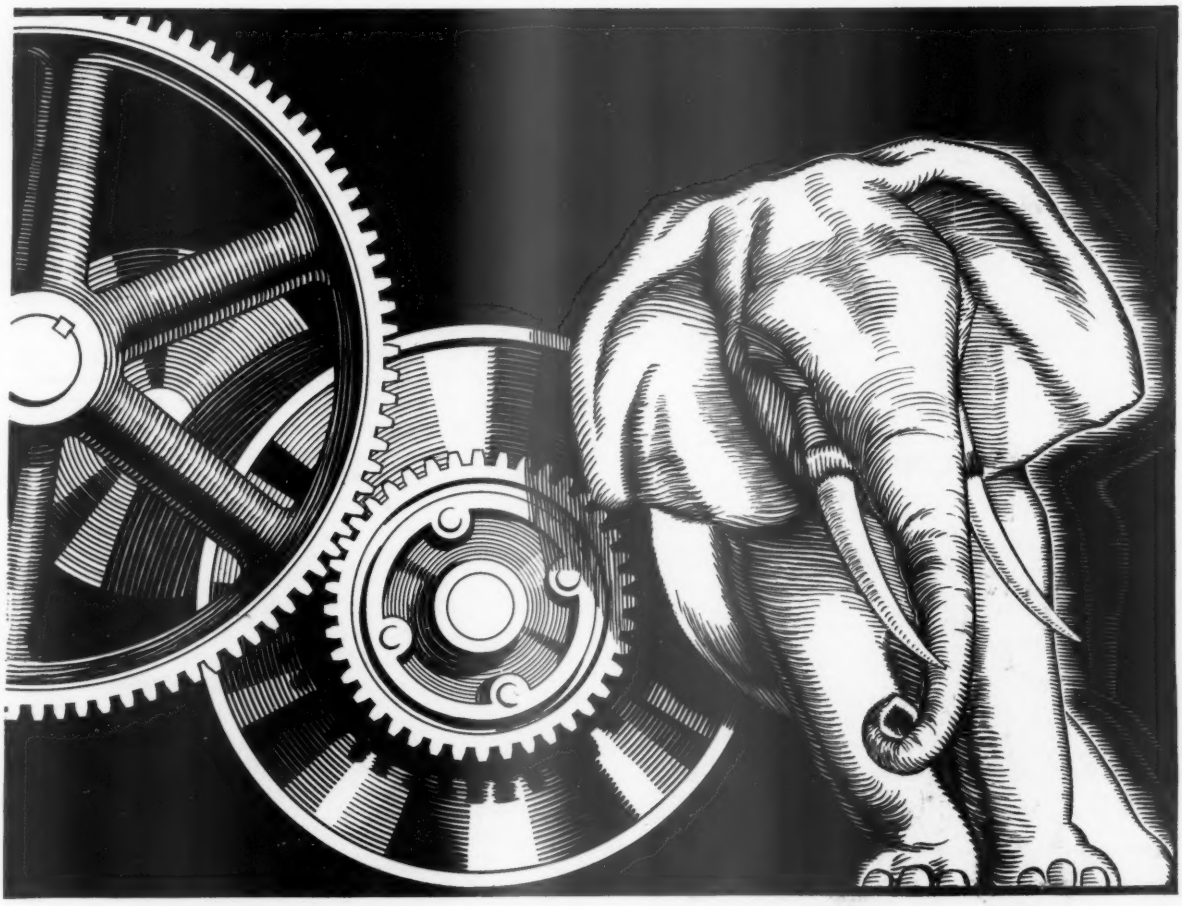
O, let me like a soldier fall
  In some tremendous fight;
I fear no foe or cannon ball —
  (Hi! are my glands all right?)
In slothful ease let cowards loll
  While I on carnage sup.
(But kindly pass the adrenal
  To get my dander up.)

My country, 'tis of thee I think,
  My soul with ardour fills.
(One moment, Doctor, while I sink
  Your latest dose of pills.)
Be mine the patriotic line,
  The true heroic stuff!
(But, gosh! I hope that gland of mine
  Is duly up to snuff.)

I do not care how fierce the threat,
  Nor how forlorn the hope.
(That is, provided I can get
  The right degree of dope.)
Now let the butchery begin,
  I shall not flinch or fly —
Ho! drench me with adrenalin
  That I may do or die!

But the public has not uniformly acted with such sanity on the great body of distorted information that has been thrown at them about science, particularly endocrinology — the science of the ductless glands. From time to time, The Review has had the privilege of presenting carefully prepared papers on this subject, free from sensationalism and distortion, yet interesting and readable to the layman. "Causes of Misbehavior," presented on page 327, is another article in this series treating of the possible endocrine factors in the behavior problems of childhood. Its author, ALLAN W. ROWE, '01, is Chief of Research at the Robert Dawson Evans Memorial for Clinical Research and Preventive Medicine, an organization formed for systematic study in many branches of medicine. It maintains departments in clinical research, biochemistry, immunology, bacteriology, pathology, physiology, pharmacology, and several of the specialized branches. Under Dr. Rowe's direction research has been conducted along definite scientific lines and the successful results have been applied directly to the study and care of the sick. ¶ Twice before Dr. Rowe has written of different phases of his work at the Evans Memorial Hospital. In July, 1928, he wrote on the functions of the endocrine glands, and in February, 1929, he went on to reveal some of the methods of the endocrinologists. In this issue, he goes yet a step further into the relation of

(Continued on page 316)



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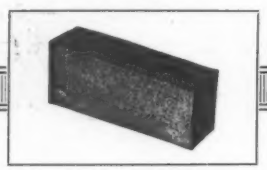

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THE TABULAR VIEW

(Continued from page 314)

glandular activity and human activity and behavior. ¶ An editorial on the development of biochemistry in the United States in the *Journal* of the American Medical Association (February 21, 1931) is pertinent to this comment as it concerns exactly the sort of work in which Dr. Rowe is engaged. We quote in part: "Physiologic chemistry — or biochemistry, as it has been commonly designated more recently — has long since come of age. The subject has become an important and integral part of the study of medicine and the practice of the art. The special technic of biochemistry has been introduced into clinical diagnosis to such an extent that it competes in prominence with physical procedures and with bacteriologic and immunologic methods of examination and research. A recent writer has remarked that today it is quite safe to state that in the United States there is hardly a university worthy of the name that does not have on its staff one or more competent investigators in physiologic chemistry and a well-equipped laboratory with resources adequate for at least some lines of research in this field. Added to these centers of research are the many special laboratories connected with the larger hospitals of the country where investigations of a chemico-physiologic character are conducted; the many research institutions and foundations with their large endowments, where many biochemists of national reputation are to be found; and lastly, the various government bureaus at Washington with their well-equipped laboratories and trained workers who have contributed largely to the development of knowledge of a chemico-physiologic nature in many directions." At one time, it goes on to say, Americans desirous of gaining knowledge and experience in this work were obliged to go to Germany to study methods. Dr. Rowe himself holds a degree from a German university.

AS AN engineer, GEORGE A. RICKER has encountered many interesting experiences. Perhaps the most dramatic of these was in connection with his work in building the Niagara Gorge Railroad, an account of which is given in his article "Niagara's Wayward Youth." Few people can boast of as intimate acquaintance with this most powerful of waterfalls. Such an enterprise required imagination and daring as well as engineering ability. ¶ Mr. Ricker became connected with this work through two of his clients, Captain John M. Brinker and Hon. Herbert P. Bissell, the promoters of the railroad and afterwards President and Secretary-Counsel, respectively. These men had confidence in his ability to be successful in an undertaking that even conservatives termed rash, and others, more freely spoken, considered a crazy scheme. The money to build with was furnished by a small group of enthusiasts as no orderly financing was possible because almost everyone consulted, including engineers, branded the project as impracticable. In 1901 the roadbed, track and

(Concluded on page 318)

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PLATE II
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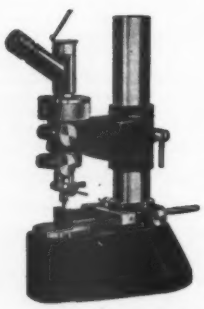

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THE TABULAR VIEW

(Concluded from page 316)

equipment were in good shape and over a million and a half tourists saw the wonderful gorge from end to end without a care for the cost or the troubles that had been undergone in making the ride possible. The chief point which Mr. Ricker particularly emphasizes is the possibility of nailing down the Falls where they are.

William P. Cutter is a Contributing Editor to The Review. This month he writes of the proposed development of the Hackensack Meadow Region in his article entitled "The City of Tomorrow." The region in itself is about as unpromising as that through which Childe Roland made his gruesome journey to the Dark Tower in Browning's poem. This territory offers the same challenge to the vigorously persistent engineer of today as did that barren plain to the knight of old. The modern engineer, however, does more than blow a defiant trumpet in the face of opposition as there is in his makeup the unquenchable urge to build. ¶ The city of tomorrow is all planned and ready to build, and it has been made public in printed form in "The Regional Plan of New York and Its Environs." Unfortunately, the Board can do no more than plan for this development as it has no authority to execute such an enormous undertaking — another example of Prometheus Enchained. Mr. Cutter is engaged in research at the Harvard Business School.

The picture on the cover of this issue of The Review is reproduced from a water color by Charles H. R. Mabie of the Institute's Drawing Department. It shows the stairway in Canterbury Cathedral, up which the medieval pilgrims toiled to the shrine of St. Thomas à Becket. The original was painted at the close of a period of foreign study. ¶ Mr. Mabie began his art training as a boy under the tutelage of an older brother, an alumnus of the Institute and a practicing architect in Boston. This was a happy introduction to four years of serious study in the Massachusetts Normal Art School some years later. Following graduation, he spent four years as supervisor of Drawing and Manual Training in the town of Framingham, Mass. Then came the opportunity for study abroad, in either an English or German school. Since his home life had largely been influenced by English traditions, he quite naturally chose a London school; and since his leaning was toward creative and applied design, he chose the Royal College of Art, rather than the Academy. Here, under the guidance of Professor Lethaby and other able men, he was led into the intricacies of artistic design in its application to the industries and architecture. ¶ When the War came, Mr. Mabie returned to America with as much of South Kensington Museum and other parts of Europe, as he had been able to copy and a knowledge which Europe alone could give him. He also returned with a large part of the spirit of the Old World, something which can be felt and lived but cannot be described.

Chapter 9

Exercise 9.1